THE STUDY OF PRESERVICE TEACHERS' REACTIONS TO PROPOSED NUCLEAR POWER PLANTS IN TAIWAN: AN APPLICATION OF FISHBEIN'S MODEL

By

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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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The purpose of this study was to examine preservice teachers' beliefs and evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs, motivations to comply with important referents, and behavioral intention toward the proposal of new nuclear power plants in Taiwan. The study also attempted to utilize Fishbein's model of reasoned action to investigate the relationships among different factors related to the theory of reasoned action and to predict behavioral intention for voting in favor of building new nuclear power plants. The sample was selected from the first-year students enrolled in three teacher-training universities in Taiwan in 1992. The total number of subjects participated in the study was 774. The research instrument was composed of seven questionnaires and used a

seven-point scale to measure subjects' beliefs and evaluations of outcomes, attitude, subjective norms, normative beliefs, motivations to comply, and behavioral intention specially related to the proposal for new nuclear power plants. Also included were nine items designed to collect subjects' demographic and political party affiliation information. The instrument also included a modified version of the Nuclear Locus of Control Scale to measure beliefs concerning nuclear power plant accidents and how they may relate to nuclear policy. The data were collected during the fall term, 1992.

Results of this study indicated a majority of students expressed favorable beliefs, evaluations, attitude, and behavioral intention for voting "yes" in support of building new nuclear power plants; perceived that most important referents supported them for voting "yes"; and were willing to do most of what important referents wanted them to do. A majority of students also were concerned about potential environmental problems caused by nuclear power plants. In further analysis, supporters of Kuomintang, students living in the areas without industrial pollution, students who scored high on internal nuclear locus of control, and students who scored low on powerful others nuclear locus of control showed more favorable behavioral intention for supporting new nuclear power plants.

Results of this study indicated that Fishbein's model of reasoned action was successful in predicting behavioral intention to vote "yes" for the proposal of new nuclear power plants. The data revealed that students with favorable beliefs and evaluations of outcomes, and attitude, and who believe that most important referents support them to vote "yes," showed favorable intention to vote in favor of the proposal for new nuclear power plants.

Results also revealed that among many external factors, political party affiliation, residential area, and nuclear locus of control were better able to predict behavioral intention for supporting nuclear power plants.

CHAPTER I
INTRODUCTION

Electricity enables us to enjoy a standard of living beyond the wildest dreams of our forefathers. However, because of the growth of population, rapid development of the economy, rise in people's income, and a better quality of life, the amount of electricity needed is increasing each year in the Taiwan area. According to a survey conducted by the National Taiwan Power Company, the predicted average yearly growth rate in the use of electricity in the Taiwan area is 6.2% during the next 10 years. The power company has predicted the amount of needed electricity to be 27 million watts by the year 2000. In other words, an additional 17.7 million watts of electricity must be added to the current system in the Taiwan area by the year 2000 in order to meet the need (Shih, 1991).

In order to meet the need for electricity, all possible sources must be considered. Currently, energy sources available include hydropower, fossil fuels (oil, gas, and coal), solar energy, wind power, the temperature differences of the ocean, wave power, geothermal energy, tidal power, and nuclear energy. Hydropower is not a very good energy source for Taiwan because of the unbalanced rainfall distribution, shortened rivers, and weak soil quality which

have limited dams available for hydropower. As petroleum, most of this kind of fossil fuel must be imported from middle eastern countries that have political instability and price problems, and this kind of fuel can cause air pollution. Natural gas, another kind of fossil fuel, causes less environmental pollution, but there are also many nonenvironmental problems with this fossil fuel. The third kind of fossil fuel, coal, causes more serious air pollution (National Taiwan Power Company, 1992). Except for nuclear energy, the rest of the energy sources mentioned above are experimental or have a limited capacity for electricity (Shih, 1991). Therefore, nuclear energy is a viable option available for power in the Taiwan area. According to a report by the Nuclear Committee of Executive Yuan in Taiwan (C. L. Liou, 1991), less than 12% of electricity is derived from nuclear power plants. Adding the fourth power plant, the proportion of nuclear energy will be increased to 19% by the year 2000. Compared with 75% of power in France being nuclear energy, 19% in Taiwan is low (Hseih, 1991).

Nuclear energy can not only solve the current serious shortage of electricity in the Taiwan area, but can also provide enough electricity for prosperous growth of commercial and industrial development of Taiwan. Besides these economic benefits (Chen, 1991), there are several advantages of nuclear energy: (1) the stability of energy sources, (2) the inhibition of a greenhouse effect caused by

air pollution, (3) an environment with fewer pollutants, and (4) an inexhaustive source (W. C. Liou, 1991).

Reports on nuclear accidents and other adverse effects have affected many citizens' attitudes and beliefs about nuclear power energy. As a result, nuclear power energy becomes a very controversial issue in Taiwan. To resolve the controversy about nuclear power energy, it would be helpful to understand the attitudes and beliefs of nuclear power energy of general public, and their behavioral intention toward voting concerning the proposal of new nuclear power plants.

The theory of reasoned action developed, refined, and tested by Fishbein and Ajzen (1975) can predict and explain human behavior. This theory has been successfully applied in family planning behaviors (Fishbein & Jaccard, 1973), voting for a nuclear safeguards referendum (Bowman & Fishbein, 1978), and behavior of alcoholics (Fishbein, Ajzen, & McArdle, 1972). Other health behavior studies using the model--including blood donating behavior (Pomazal & Jaccard, 1976), marijuana use (Bearden & Woodside, 1978), mothers' infant-feeding intentions and behavior (Manstead, Proffitt, & Smart, 1983), and adolescent sexual and contraceptive behavior (Jorgensen & Sonstegard, 1984; Adler, 1987)--also have been reported.[14] Studies conducted in Taiwan examining adolescent smoking intention (Chen, 1985; Huang, 1988), undergraduates' blood-donating intentions (Hsiao,

1988), breast self-examination (Liou, 1990), and undergraduates' weight control (Yang, 1991) all supported this theory.

Because of differences in respondents and behaviors across various topics, the explanation power (R^2) for attitude and the subjective norm for every behavioral intention are different. Therefore, this study used the theory of reasoned action (Fishbein's model) to predict whether or not the undergraduate students of the teacher-training universities in Taiwan intend to support building new nuclear power plants and to describe the reasons for their intention. Undergraduate students of teacher-training universities were selected as a study population because they are trained to serve as teachers of middle and high school students, and they can play a very important role in influencing the environmental attitude of future generations, and society as a whole. The information gathered from this study will be useful to educational authorities in Taiwan in developing appropriate curriculum materials for these undergraduate students in the areas of nuclear power plants and nuclear energy, so they can educate their future students. At the same time, these results may provide the government in Taiwan with information to develop appropriate policies for nuclear power plants. The research framework of this study is illustrated at Figure 1.

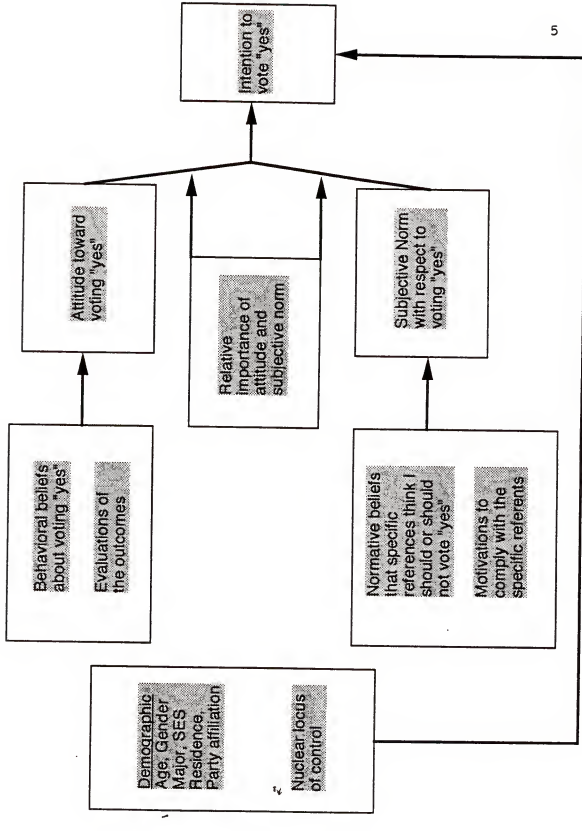
Intention to vote "yes"
Attitude toward voting "yes"
Relative importance of attitude and subjective norm
Subjective Norm with respect to voting "yes"
Behavioral beliefs about voting "yes"
Evaluations of the outcomes
Normative beliefs that specific references think I should or should not vote "yes"
Motivations to comply with the specific referents
Demographic Age, Gender Major, SES Residence, Party affiliation
Nuclear locus of control

Figure 1. Research Framework

Purpose of the Study

The purpose of this study was to examine preservice teachers' beliefs about evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs, motivations to comply with important referents, and behavioral intention toward the proposal of new nuclear power plants in Taiwan. The study also attempted to utilize Fishbein's model to investigate the relationships among different factors related to the theory of reasoned action and to predict voting behavioral intention about building new nuclear power plants. Specifically, this study was designed to

1. understand beliefs and evaluations of outcomes, attitude, and behavioral intention of subjects toward new nuclear power plants;
2. investigate the relationships among beliefs of behavioral outcomes, evaluations of behavioral outcomes, attitude, subjective norm, beliefs of the important others, motivations to comply with the important others, and external variables (both demographic variables and nuclear locus of control), and behavioral intention toward new nuclear power plants among these undergraduate students;
3. determine the predictability of Fishbein's theory of reasoned action for voting behavior on new nuclear power plants among these undergraduate students;

4. provide useful information for developing and revising curricula in nuclear power for undergraduate students of three teacher-training universities in Taiwan; and
5. provide useful information for the government in Taiwan to develop appropriate nuclear power policies.

Statement of Research Problem

The study was designed to examine the following questions:

1. What are the beliefs about behavioral outcomes--the outcomes of voting "yes" for building new nuclear power plants, evaluations of these behavioral outcomes, attitude, subjective norm, normative beliefs of important others, motivations to comply with the important others, external variables (demographic variables and nuclear locus of control), and behavioral intention toward new nuclear power plants among these undergraduate students at teacher-training universities in Taiwan?
2. To what extent can external variables (both demographic variables and nuclear locus of control) predict the beliefs about behavioral outcomes toward the new nuclear power plants among these undergraduate students?

3. To what extent can external variables (demographic variables and nuclear locus of control) predict the evaluations of behavioral outcomes toward the new plants among these undergraduate students?
4. To what extent can external variables (demographic variables and nuclear locus of control) predict normative beliefs of important others toward the new nuclear power plants among these undergraduate students?
5. To what extent can external variables (demographic variables and nuclear locus of control) predict motivations to comply with important others toward the new plants among these undergraduate students?
6. To what extent can external variables (demographic variables and nuclear locus of control) predict attitude toward the new plants among these undergraduate students?
7. To what extent can external variables (demographic variables and nuclear locus of control) predict subjective norm toward the new nuclear power plants among these undergraduate students?
8. To what extent can external variables (demographic variables and nuclear locus of control) predict behavioral intention toward the new plants among these undergraduate students?

9. What are the relationships among beliefs of behavioral outcomes, evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of important others, motivations to comply with important others, and behavioral intention toward the new plants among these undergraduate students?

Null Hypotheses

Hypothesis 1. No association exists among external variables (demographic factors and nuclear locus of control) and beliefs of behavioral outcomes.

Hypothesis 2. No association exists among external variables (demographic factors and nuclear locus of control) and evaluations of behavioral outcomes.

Hypothesis 3. No association exists among external variables (demographic factors and nuclear locus of control) and normative beliefs of important others.

Hypothesis 4. No association exists among external variables (demographic factors and nuclear locus of control) and motivations to comply with important others.

Hypothesis 5. No association exists among external variables (demographic factors and nuclear locus of control) and attitude toward the new nuclear power plants.

Hypothesis 6. No association exists among external variables (demographic factors and nuclear locus of control) and subjective norm toward the new nuclear power plants.

Hypothesis 7. No association exists among external variables (demographic factors and nuclear locus of control) and behavioral intention toward the new nuclear power plants.

Hypothesis 8. No association exists among the beliefs of behavioral outcomes: the outcomes of voting "yes" for building new nuclear power plants, evaluations of these behavioral outcomes, attitude, subjective norm, normative beliefs of important others, motivations to comply with important others, and behavioral intention.

Need for the Study

Nuclear energy is a viable alternative source of energy in Taiwan. There are many advantages of nuclear energy, but some people in the Taiwan area are concerned about the negative effects. The main concerns include the potential accidents and the impact of radioactivity on human health. Although several experts have reported that nuclear power plants are safe (Hendrie, 1983; Matuszek, 1983; W. C. Liou, 1991), there have been nuclear power accidents such as those at Three Mile Island and Chernobyl.

In regard to the impact on human physical health, some researchers have suggested that radiation may cause early diseases and death from destruction of bone-marrow, or late diseases and death from cancer or genetic mutation (U.S. Nuclear Regulatory Commission, 1975; Jessop & Horsley, 1985). The radiation released by Chernobyl nuclear accident

has caused residents of the former USSR to have more lung cancer, cancers of the thyroid and breast, and leukemia (Broadway, Smith, Norwood, & Porter, 1988; Ginzburg & Reis, 1991). In regard to the impact on mental health, research has indicated that residents living near nuclear power plants show varying degrees of psychological problems (McKinnon, Weisse, Reynolds, Bowles, & Baum, 1989; Lindell & Perry, 1990).

At the present time, nuclear energy is a very controversial topic in Taiwan, and it is important to help clarify the value of nuclear energy for people in Taiwan. There was a serious event on Oct 3, 1991 in Taiwan, that caused one policeman to be killed and several others to be seriously wounded by protesters when a group of policemen took down a barrier that was built by anti-nuclear protesters at the site of the fourth nuclear power plant (Huang, 1991). That violence shocked most people in Taiwan and attracted many interests in analyzing the beliefs and attitudes concerning nuclear power plants.

Many times in the future, the general population will vote on approval of new nuclear power plants in Taiwan, so the understanding of nuclear energy is crucial. Undergraduate students at teacher-training universities in Taiwan soon will be teachers at junior or senior high schools, and they will play an important role in forming students' concepts about environment. This study attempted

to assess beliefs of behavioral outcomes, evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of the important others, motivations to comply with important others, external variables (demographic variables and nuclear locus of control), and behavioral intention toward new nuclear power plants among these undergraduate students, and to analyze the relationships among these variables. This study also was designed to use Fishbein's model of reasoned action to predict behavioral intention through both attitude and subjective norm toward the new nuclear power plants, to predict attitude and subjective norm of voting "yes" for building new nuclear power plants by way of both beliefs of behavioral outcomes and evaluations of behavioral outcomes, and both normative beliefs of important others and motivations to comply with important others, respectively. Although the government in Taiwan already has decided to build the fourth nuclear power plant, the results of the study could provide educational authorities as well as teacher educators information to improve environmental education in relation to nuclear power plants and nuclear energy at three teacher-training universities, and also could assist the Taiwan government in developing appropriate policies for nuclear energy.

Delimitations

1. The study selected a cluster random sample of 33% of first-year undergraduate students enrolled in three teacher-

training universities during the fall semester of 1992 in Taiwan, ROC.

2. Two instruments: the open-ended elicitation questionnaire and the closed-format questionnaire were used to assess subjects' self-reported beliefs, attitude, voting behavioral intention toward the proposal of nuclear power plants.

3. To increase the precision of translation, the validity of the Chinese version of the questionnaire was checked by a Chinese-American professor and two professors at National Taiwan Normal University (NTNU) with research experience related to the present study.

4. Self-reported questionnaires were modified from Fishbein's study and validated before they were used to collect data.

Limitations of the Study

The study contains the following limitations:

1. The study population did not include all first year undergraduate students at three teacher-training universities.

2. Findings depended on the ability of the instrument to accurately assess beliefs, attitude, and behavioral intention of subjects.

3. Findings of the study also depended on the accuracy of translations from English to Chinese to assess beliefs, attitude, and behavioral intention of subjects.

4. The undergraduate students at three teacher-training universities provided self-reported data on their behavioral beliefs and evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of the important others, motivations to comply with the important others, and nuclear locus of control. The self-reported data may have been affected by normative response bias.

Assumptions

1. Subjects participating in the study adequately represented the population of first-year undergraduate students at the three teacher-training universities.

2. The questionnaires used by the study were adequate to obtain data.

3. The translation of questionnaires from English to Chinese was acceptable to obtain data for the study.

4. The subjects who participated in the study completed the survey instrument truthfully and to the best of their ability.

5. Subjects' motivation and candor were adequate for the purpose of the study.

Definition of Terms

The operational definitions of key terms in the study are as follows:

Preservice teachers are undergraduate students in the three teacher-training universities in Taiwan, National

Taiwan Normal University, National Chang-Hua Educational University, and National Kaohsiung Normal University.

Fishbein's model of reasoned action is a social psychological theoretical model which predicts behavioral intentions from beliefs, evaluations, normative beliefs, and motivations to comply (Fishbein & Ajzen, 1975).

Behavioral intention is a person's plan to perform a behavior or more specifically the subjective probability of the person that he/she will perform the behavior in question (Fishbein & Ajzen, 1975).

Attitude is a bipolar evaluative judgment indicating the amount of effect for or against an object or behavior.

Vote for new nuclear power plants is an assumption to vote for or against building new nuclear power plants in Taiwan.

Beliefs of behavioral outcomes are the possible linkages between a vote for or against the question and the consequences. These are measured through the use of bipolar scales with adjective endpoints of "likely--unlikely."

Evaluations of behavioral outcomes is an individual's judgment of the value of the consequences. These are measured through use of bipolar scales with the adjective endpoints "good--bad" (Page, 1982).

Subjective norm is an individual's perception that most people who are important to him/her think he/she should or should not perform the behavior in question.

Normative beliefs of the important others are an individual's beliefs about what important others will the individual should or should not do to vote "yes." These are measured on bipolar "I should--I should not" scales in which subjects indicate the likelihood that each relevant other thinks the subject should vote for or against new nuclear power plants.

Motivations to comply with the important others is an individual's incentive to conform to what relevant others will the individual should do. These are measured by having subjects rate their motivations to comply with each relevant other on bipolar scales with "I want to do--I do not want to do" endpoints (Page, 1982).

Nuclear Locus of Control Scales This instrument is constructed to assess beliefs as to whether nuclear accidents and nuclear policy decisions are or can be influenced by oneself, powerful others, or chance. Therefore, Nuclear Locus of Control Scales contain internal nuclear locus of control, powerful others nuclear locus of control, and chance nuclear locus of control.

CHAPTER II
REVIEW OF THE LITERATURE

Introduction

The purpose of this study was to utilize Fishbein's model of reasoned action to identify the attitudinal and social factors that might predict behavioral intention of undergraduate students at teacher-training universities in voting regarding proposed nuclear power plants and to determine the differences in the beliefs and attitudes about new nuclear power plants among these undergraduate students with different demographic backgrounds. In other words, this research project attempted to investigate the ability of Fishbein's model of reasoned action to predict behavioral intention and to provide a better understanding of the attitudinal and social normative correlates of the proposal of nuclear power plants.

The review of literature is presented in the following sequence:

1. health concerns about radioactive materials and nuclear power plants;
2. socioeconomic concerns about nuclear energy and related radioactive events;
3. control and prevention of nuclear power plant accidents;

4. effects of external variables on the approval of nuclear power energy;
5. mass media and behavioral intention related to nuclear power energy;
6. Fishbein's model of reasoned action and nuclear power plants;
7. measurement of the nuclear power plant attitude-behavior relationships with nuclear locus of control; and
8. summary.

Health Concerns about Radioactive Materials and Nuclear Power Plants

Influence of Radioactive Materials on Human Health

Since the discovery of x-rays by Roentgen in 1895 and of radioactivity by Becquerel in 1896, incidents and severe accidents have occurred, involving either workers or the general public.

Deleterious effects of radiation were described as early as 1897 by Becquerel, who observed an erythema on his abdomen and related it to radioactive material in his waist pocket. A direct relationship between the erythema and the source was proved when he placed the radioactive material in the opposite pocket. When the same experiment was performed by Pierre Curie, the results were confirmed. In 1990, Nenot published details of the epilation of the scalp in a young child exposed to high doses of x-rays.

In 1978, Najarian and Colton reported a fivefold increase in mortality due to leukemia and a twofold increase in all cancers among workers who had been exposed to relatively low doses of ionizing radiation while overhauling and building nuclear submarines at the Portsmouth (New Hampshire) Naval Shipyard (PNS). Several years later a study by Rinsky et al. (1981) was done at the request of the Subcommittee on Health and the Environment of the United States House of Representatives. The objectives of the study were to determine whether the previously reported high risk of leukemia and of other cancers among nuclear workers at PNS (Najarian & Colton, 1978) could be corroborated and to evaluate dose-response relationships between radiation and cancer. The findings of the study were consistent to the findings of Najarian and Colton.

Hanford Works in Richland, Washington, is one of the largest atomic plants in the United States, and most of the staff who were exposed to low doses of ionizing radiation were concerned about manufacture of radioactive substances. The Hanford data have been analyzed by a number of investigators. Samuel (1974) was one of many investigators who analyzed deaths of Hanford workers as part of a general study of occupational mortality in the state of Washington, and he found the proportion of Hanford deaths due to cancer of the pancreas to be significantly higher when compared with the corresponding proportion for the state as a whole.

Data from another Hanford study conducted by Mancuso, Stewart, and Kneale (1977) showed that sensitivity to the cancer-induction effects of radiation was low between 25 and 45 years of age. However, at younger and older ages there was a cancer hazard associated with low level radiation, which affected bone marrow cancers more than other neoplasms and cancers of the pancreas and lungs more than other solid tumors. In 1976, an ad hoc committee of four leading epidemiologists and statisticians reviewed the Mancuso et al. analysis. Their analyses of the data confirmed the same positive correlations with multiple myeloma and cancer of the pancreas (Hutchison et al., 1979).

A study of the Hanford plant conducted by Gilbert and Marks (1979) showed a statistically significant trend was obtained for multiple myeloma and cancer of the pancreas, but no evidence of a positive correlation was found for 13 other cancers including those more typically associated with radiation exposure such as myeloid leukemia and lung cancer. The International Commission on Radiological Protection (1977) had given estimates of the risk of fatal cancer from low doses of ionizing radiation for use in the protection of workers, but Mancuso et al. (1977), based on data from the Hanford plant, thought those estimates substantially under-reported the hazard. However, no evidence was found to show those risk estimates were too low (Darby & Reissland, 1981),

but there was increased mortality from multiple myeloma in the higher-dose categories.

In a study conducted by Smith and Douglas (1986), the mortality of 14,327 people who had been employed at the Sellafield plant of British Nuclear Fuels at any time between the opening of the site in 1947 and 31 December 1975 was studied up to the end of 1983. They found an excess of deaths from myeloma, but there was no evidence of an excess of leukemia. A historical cohort mortality study was conducted by Checkoway, Pearce, Crawford-Brown, and Cragle (1988) among 6,781 white male employees of a nuclear weapons materials fabrication plant--the Y-12 plant located in Oak Ridge, Tennessee, built in 1943 as a facility for the enrichment of uranium for nuclear weapons--for the years 1947-1979. Exposures of greatest concern were alpha and gamma radiation emanating primarily from insoluble uranium (U^{238}) compounds. The findings of the study showed that mortality excesses of lung and brain and central nervous system cancers were seen from comparisons with national and state rates. Dose-response trends were detected for lung cancer mortality with respect to cumulative alpha and gamma radiation, with the most pronounced trend occurring for gamma radiation among workers who received ≥5 rem of alpha radiation. In 1990, epidemiologic studies of workers at the Hanford Site, Richland, Washington; the Oak Ridge National Laboratory, Oak Ridge, Tennessee; and the Rocky Flats

Nuclear Weapons Plant, Denver, Colorado, exposed occupationally to protracted low doses of radiation, provided a direct assessment of health effects resulting from such exposure. The findings of those studies indicated a higher risk of leukemia, especially for Oak Ridge workers. There also was wide agreement on a general mathematical formula for the relationship between low doses of ionizing radiation and cancer incidence (Brown, 1976, 1977; Upton, 1977; Steward, Webb, & Hewitt, 1958).

A study conducted by Tolley, Marks, Buchanan, and Gilbert (1983) provided a second updated analysis of the data presented originally by Gilbert and Marks (1979). The first update by Gilbert and Marks, which was based on 12,522 workers initially employed at Hanford before 1965, included deaths up to May 1977, so the study population was expanded to include workers initially employed during and after 1965, and minor corrections of employment dates and other occupational information were made. The analysis was based on a study population of 15,992 white male workers who were employed at Hanford for at least one year. The results of the study indicated significance of the test for trend toward multiple myeloma was consistent with that obtained in previous analyses (Gilbert & Marks, 1979, 1980). There were, however, no new multiple myeloma deaths in that second updated analysis, and the significance for trend in

pancreatic cancer reported previously in the first update analysis had disappeared.

In a study conducted by Gilbert, Petersen, & Buchanan (1989), the study population included all workers other than construction workers who were initially employed at the Hanford site during the years 1944 through 1978 by U.S. Department of Energy contractors. Employment records (which included data on age, sex, race, dates of employment and termination, and job classification) were available for 31,500 male and 12,600 female study population members, and analyses of mortality of workers at the Hanford site were updated to include an additional three years of data (1979-1981). Deaths occurring in the state of Washington in the years 1982-1985 also were evaluated. After the analyses, Hanford workers continued to exhibit a strong healthy worker effect with death rates substantially below those of the general U.S. population. Comparisons by level of radiation exposure within the Hanford population provided no evidence of a positive correlation between radiation exposure and mortality from all cancers combined or mortality from leukemia. Estimates of cancer risk due to radiation were negative but confidence intervals were wide, indicating that the data were consistent with no risk and with risks several times larger than estimates provided by major groups concerned with risk assessment (Gilbert et al., 1989). Also little evidence of adverse effects was found in the study of

Darby and Reissland (1981). At the Sellafield plant of British Nuclear Fuels, the mortality of all 14,327 people employed at any time between the opening of the site in 1947 and 31 December 1975 was studied up to the end of 1983. Compared with the general population, workers had a statistically significant lower incidence of liver and gall bladder cancer, lung cancer, and Hodgkin's disease except for excesses of deaths from myeloma. When exposure up to the time of death or up to two years before death was considered, there were no statistically significant positive associations between accumulated radiation dose and death rates from bladder cancer, multiple myeloma, leukemia, and all lymphatic and hematopoietic neoplasms (Smith & Douglas, 1986). There also were no adverse effects on workers at the Rocky Flats Nuclear Weapons Plant, which produced weapons using plutonium (Wilkinson et al., 1987). According to the results of the study conducted by Wilkinson et al. (1987), death rates lower than U.S. death rates were found for all causes of death, all cancers, and lung cancer, and no bone cancer was observed. Nevertheless, those findings suggested that increased risks for several types of cancers--esophageal, stomach, colon, and prostate cancers, lymphosarcomas, and reticulum cell sarcomas--could not be ruled out at the time for individuals with a plutonium body burden of ≥2nCi.

Influence of Nuclear Power Plants on Physical Health

Because of the concern over possible health effects associated with nuclear power plants, there have been many studies researching the relationships between health and nuclear power plants. In 1990, Hatch and Susser examined whether rates of cancer in children were related to background gamma ray exposure. The data from a national monitoring program of nuclear facilities were used to map the distribution of background gamma radiation for 69 small geographical subunits (average population 2,300) within 10 miles of the Three Mile Island nuclear plant. An association was found for incidence of childhood cancers as a whole (odds ratio = 2.4), and for leukemia. The odds ratio also was elevated but confidence limits were very wide (Hatch & Susser, 1990).

In the report by Johnson (1980), it has been estimated that a serious accident at San Onofre, with portions of the nuclear fuel melting and a small portion of the available radionuclides released outside the containment building (category 4 accident), could result in about 350 additional cancer deaths if no protective actions were taken. Using estimates by Land (1980) and the Committee on the Biological Effects of Ionizing Radiation, National Academy of Science, (1980) for the linear dose-response model, a single absorbed dose of 10 rems of gamma or beta radiation among 500,000 persons, over the lifetime of these individuals, would

result in 835 additional cancer deaths, which is a 1 percent increase in the normal expectation of total cancer deaths.

In 1978, the United Kingdom Atomic Energy Authority, desiring an independent inquiry, asked the Medical Research Council to appoint an epidemiological group to investigate the mortality of its employees. The analysis was, therefore, conducted of 3,373 deaths among 39,546 people employed by that Authority between 1946 and 1979, the population having been followed for an average of 16 years. The findings were that mortality from four causes, namely, testicular cancer, leukemia, thyroid cancer, and non-Hodgkin's lymphoma, were above the national average (Beral et al., 1985).

According to the view of Milhaud (1991), the Chernobyl disaster was the worst accident since the beginning of nuclear power plants, so the study of that accident had to concentrate on assessing the damage caused in both the Soviet Union and Europe as a whole. In the early stages following the accident, radioiodine represented the main hazard, and in the later stages the main danger was whole body exposure to radiocaesium. Milhaud thought that the five main disorders caused by the accident were thyroid malignancies, leukemia, other types of cancers, genetic defects, and teratogenic anomalies, as follows:

(1) Thyroid malignancies. The possible consequences of irradiation of the thyroid gland could amount to 308

malignant tumors in the most contaminated regions, 330 malignant tumors in the most contaminated provinces, and 641 malignant tumors in the Central European region. That means the percentage of malignant tumors in excess of the spontaneous level may reach .9% among adults and be as high as 5% among children.

(2) Leukemia. There was a 1.5% excess over the spontaneous level in zones of strict control, a .13% excess over the spontaneous level in the most contaminated provinces, and a .04% excess over the spontaneous level in the Central European region of the U.S.S.R.

(3) Other forms of cancer. The projected number of fatal malignant tumors may add .04% to .01% to the natural occurrence.

(4) Genetic defects. For the first two generations following the accident, the genetic consequences in excess of the spontaneous level may reach 1% in the zone of strict control and .01% in the Central European region of the former Soviet Union.

(5) Teratogenic anomalies. The exposure in utero of 4,500 children born in the strictly controlled zone in the year following the accident may add 1.9% to the spontaneous level of congenital developmental anomalies.

Milhaud also suggested that hundreds of thousands of people were involved in the accident, requiring mass surveys to produce a representative view (Milhaud, 1991; Galle &

Guiraud, 1987; Pellerin, 1988). Broadway et al. (1988) also found that the risk estimates of the Chernobyl accident projected three excess lung cancer deaths and an additional four deaths due to cancers of the thyroid and breast and leukemia in the U.S. population, but they indicated that the cancers which were projected to develop in the U.S. population as a result of the Chernobyl accident would be indistinguishable from those which were expected to occur in the United States from other causes.

On the other hand, cancers among the 159,684 residents living within a 10-mile (16-km) radius of the Three Mile Island nuclear plant were studied by Hatch, Beyea, Nieves, and Susser (1990), and for accident emissions, they failed to find definite effects of exposure on the cancer types in population subgroups thought to be most susceptible to radiation. No associations were seen for leukemia in adults or for childhood cancers as a group. Moreover, rates of childhood leukemia in the Three Mile Island area were low compared with national and regional rates. In the report of Miller, Cottrell, Loar, and Witherspoon (1990), a project was completed by the Oak Ridge National Laboratory (ORNL) to estimate the concentrations of radionuclides in the environment resulting from the release of radioactive materials in the liquid waste effluent from the Rancho Seco Nuclear Power Plant (RSNPP) and to estimate possible radiation doses to man resulting from current environmental

concentrations. This radioactive contamination occurred primarily along streams receiving effluent from the plant and in fields irrigated with water from these streams. The ingestion of fish was the single most important pathway identified in this analysis. However, all specific pathways of exposure and usage factors were not precisely known for a complete dose assessment of current and potential use of contaminated water and soil around the RSNPP, and the liquid effluent radionuclide released from the RSNPP posed no significant health hazard to persons living near the RSNPP.

In the study by Goldsmith, Boice, Hrubedc, Hurwitz, Goff, and Wilson (1989), career radiation doses for 8,961 male workers at the Calvert Cliffs Nuclear Power Plant (CCNPP) located in rural Maryland were determined for both utility (n = 4,960) and contractor (n = 4,001) employees. Workers were followed from the time of first employment at CCNPP (including plant construction) to the end of 1984 (mean follow-up = 5.4 year). On average, worker mortality from all causes was 15% lower than that of the general population of the U.S., probably due to healthier members of the population being selected for employment. Their investigation demonstrated that historical information was available from which career dosage could be constructed and that it was feasible to conduct epidemiologic studies of nuclear power plant workers in the U.S.

In the report of Enstrom (1983), cancer mortality patterns in southern California have been examined for time periods before the San Onofre nuclear power plant began commercial operation in 1968 through 1978. This was one of America's older plants and was surrounded by major population centers in Orange, Riverside, and San Diego Counties. Infant mortality rates and age-adjusted mortality rates for leukemia, lung cancer, all cancer, and all causes have been calculated and compared for Orange, Riverside, and San Diego Counties, for California, and for the United States during 1960-1978. In accordance with the findings of the study, the cancer and total mortality rates near San Onofre have remained essentially identical to the corresponding rates in California and the United States from 1960 to 1978. There have been no significant radiation releases to the population surrounding the San Onofre plant, and the cancer rates showed no patterns which have been influenced by the presence of the plant. Although no radiogenic health effects would be expected, these results did provide a means of assessing overall mortality trends in the population.

Influence of Nuclear Power Plant Accidents on Mental Health

It was pointed out earlier that the main health effect of a reactor accident of a nuclear power plant, especially for the Three Mile Island (TMI) accident, was the impact of the associated psychological stress (Wald, 1983). In order

to assess the impact of the accident at TMI, telephone interviews were conducted six months later with 324 nuclear workers assigned to TMI and 298 workers assigned to a comparison plant of the Philadelphia Electric Company at Peach Bottom (PB). Examination of PB-TMI differences revealed the following: TMI workers reported greater exposure to radiation at the time of the accident and felt that their health thereby had been endangered. The TMI workers experienced more uncertainty and conflict at the time of the accident. Coping responses such as seeing a doctor, taking drugs, and increasing alcohol consumption were infrequent, and over 40 percent of TMI workers wished to leave but did not do so because of work obligations. The TMI workers also reported much lower job satisfaction and much greater uncertainty about their job future, and experienced much greater job tension and lower occupational self-esteem (supervisors only). At the time of the accident, TMI workers reported experiencing more periods of anger, extreme worry and extreme upset, and more psychophysiological symptoms. Six months after the accident, some persistence of these feelings and symptoms was evident. Demoralization was greater primarily among TMI nonsupervisory workers, and presence of a preschool child at home enhanced the impact of the accident, but primarily among TMI supervisors (Kasl, Chisholm, & Eskenazi, 1981).

The study conducted by Baum, Gatchel, and Schaeffer (1983) evaluated the psychophysiological impact of a powerful environment stressor--the uncertainty and threat during the aftermath of the nuclear accident at TMI. The TMI residents were compared with samples of people living near an undamaged nuclear power plant, people living near a traditional coal-fired power plant, and people living in an area more than 20 miles from any power plant, and urinary catecholamine levels were assayed in order to examine chronic stress-related sympathetic arousal. Results indicated that residents of the TMI area exhibited more symptoms of stress (self-report, performance, and catecholamine levels) more than one year after the nuclear accident than did people living in the comparison areas (Baum et al., 1983). Psychological stress has been shown to affect immune system status and function, but most studies of this relationship have focused on acute stress and/or laboratory situations.

The study conducted by McKinnon et al. (1989) compared total numbers of leukocytes and lymphocyte subpopulation and antibody titers to latent and nonlatent viruses among a group of chronically stressed individuals living near the damaged TMI nuclear power plant with those of a demographically comparable control group. Urinary catecholamine and cortisol levels also were examined. The results were that residents of the TMI area exhibited

greater numbers of neutrophils, which were positively correlated with epinephrine levels, and that the TMI group also exhibited fewer B lymphocytes, T-suppressor/cytotoxic lymphocytes, and natural killer cells. These differences in immune status may be related to chronic stress evidenced by TMI residents' fairly constant expression of symptom distress and physiological arousal relative to comparable groups up to five years after the accident. Associations between urinary catecholamine and some lymphocyte subpopulations suggested that chronic stress-related sympathetic effects may be related to long-term changes in the status of the immune system. The report suggested that the magnitude of the stress response at TMI has been mild, but this did not eliminate the prospect of negative health outcomes, especially in light of the finding that chronic stress may affect long-term immune status (McKinnon et al., 1989).

Much research at TMI also has reported evidence of psychological stress and mental health problems including demoralization, fear, and emotional disturbances (Dohrenwend, Dohrenwend, Kasl, & Warheit, 1979; Flynn, 1979; Houts, Miller, Tokuhata, & Ham, 1980). Other studies have reported on the continuing effects, including increased risk for depression, anxiety, and heightened symptom reporting up to nine months after the accident (Bromet, 1980a, 1980b; Flynn & Chalmers, 1979). These chronic problems may reflect

a chronic perception of threat by area residents (Lazarus, 1966). Some data suggested that many residents of the TMI area continued to perceive threats as a result of the nuclear plant's presence, and given the continued presence of sources of stress in the TMI area, it was predicted that TMI residents would exhibit emotional disturbances symptomatic of stress (Flynn & Chalmers, 1979).

Regarding another nuclear plant accident, assessments of public perceptions of the characteristics of a nuclear power plant accident and affective responses to its likelihood were conducted five months before and one month after the Chernobyl accident. The results showed that the frequencies of both thought and discussion about a nearby nuclear power plant had increased, and the residents were moderately concerned about the health threat, but there was a significant decrease in concern for two personal consequence--expectations of cancer and genetic effects. Normal daily activities were changed only to a minimal extent, and few specific actions were taken to protect themselves and their families (Lindell & Perry, 1990). In Newcomb's report (1989), the samples of students from the United States collected in 1984, 1986, and 1987 showed some increased concern about nuclear power, particularly in 1986 after the Chernobyl accident, and showed a general increase in nuclear concerns, fears, and anxiety. Emotional distress was significantly correlated with a general factor of

nuclear anxiety, as well as specifically with nuclear concern and fear for the future. However, McDaniel's report (1988) seemed to imply that nuclear power became less feared after the accident at Chernobyl, and this issue deserves further examination.

Socioeconomic Concerns about Nuclear Energy and Related Radioactive Events

For simplicity, it is possible to distinguish two types of nuclear accidents: (1) events that involve large groups of the population, and (2) events that involve only a limited number of individuals and which concern, most often, the workforce. The events of the first type are relatively rare, which is not the case for the second type. Whereas events of the first type cannot be ignored, it is certain that many from the second are not reported, especially when they do not result in severe consequences (Nenot, 1990).

Accidents Involving Large Groups of the Population

These events are rare and only seven accidents deserve to be reported, among which two, although important, produced no victims because of the efficiency of the safeguards or countermeasures. Both accidents happened with reactors, the first after a fire at Windscale, U.K., (uranium-graphite, air-cooled reactor) in October 1957, resulting in doses below 1 mSv to the most exposed individuals, and the second after a succession of human errors at the Three Mile Island power reactor, U.S.A., in March 1979, with doses of the same order of magnitude or

even lower (U.S. Government Printing Office, 1979; Crick & Linsley, 1982; Clarke, 1989).

The five other accidents were much more serious from the point of view of health consequences (Lushbaugh, Hubner, & Fry, 1980; Lushbaugh, 1989) as follows:

Marshallese population and the Japanese fishermen, Pacific Ocean, 1954. On 1 March 1954 U.S. authorities performed a thermonuclear test at the Bikini Atoll, which resulted in high-activity fallout on four atolls of the Marshallese Islands, involving 239 Marshallese and 28 American servicemen (Conard, 1980). Lesions of the skin developed within the following days and weeks, and the follow-up during a 25-year period showed mainly the development of thyroid abnormalities, with growth retardation in a number of exposed Rongelap children, the development of thyroid nodules which appeared between 1964 and 1979, and thyroid hypofunction. At the same time, the boat Fukuryumaru (The Lucky Dragon) was about 100 miles from Bikini, out of the prohibited area, but unfortunately was exposed to radioactive fallout produced by the test. Three hours after the test, white ash began to fall on the vessel for about four and one-half hours, and the fishermen gave up fishing and returned to their base at Yaizu on 14 March 1954. Afterward, all fishermen showed various symptoms of the acute radiation syndrome, followed by skin lesions and epilation, and spermatogenesis was severely depressed and

lasted up to eight months for the most exposed to recover. One fisherman died in September 1954 due to that event (Kumatori, Hubner, Fry, 1980).

Southeast Urals, U.S.S.R., 1957. In 1957 a large area was contaminated in the Ural mountains, more precisely in the Cheliabinsk, Sverdlovsk and Tyumensk provinces, after an atmospheric release of fission wastes. That accident, which remained confidential for more than 30 years, happened in the nuclear complex of Kyshtym, built in the 1940s for the development of the Soviet military program. An area of 15,000 square kilometers with 270,000 inhabitants was contaminated, and rehabilitation of the contaminated areas started in 1958 and 1959 with plowing under the surface layer of agricultural land of 20,000 hectares, followed in 1960 and 1961 by deep plowing to a depth of more than 50 cm of 6,200 hectares. The regulatory limit for the ingestion of milk was exceeded for four years, but the population exhibited no excess of acute or long-term effects (up to two generations) (Nikipelov, 1989; Ternovskij, 1989).

City of Juarez and surrounding area, Mexico, 1983-1984. In December 1983 the seal of a Co^{60} radiotherapy head (Picker C-3000 therapy unit) containing approximately 6,000 pellets of 2.6 GBq each was broken open, releasing the radioactive pellets over a wide area in Juarez, Mexico. The release contaminated a junkyard, the truck used to haul the device, and the surrounding roads. The whole sequence of events

became known by chance one month later, when a truck loaded with steel rods made from scrap took a wrong turn at the site of the Los Alamos National Laboratory in New Mexico (U.S.A.). In the meantime, the steel foundries melted those radioactive pellets along with scrap metal and sent about 500 tons of hot reinforcing rods to the United States. In addition, a number of metal table supports, sold to the United States, contained Co^{60}, but in much smaller amounts. That event had been defined as the first "international" accidents, the consequences of which could never be assessed with accuracy (Secretaria de Energia, Mexico, 1985).

Chernobyl reactor, Ukraine, U.S.S.R., 1986. On 26 April 1986 an accident occurred at the fourth unit of Chernobyl nuclear power station in the Ukraine, which resulted in the destruction of the reactor core and part of the building in which it was housed. Only the station staff and the rescue services (mainly firemen) received doses which endangered life. The fire ended on 6 May. During that period, due to the high temperature during the release, a substantial plume arose, taking released radioactive materials to high altitudes. The complex meteorological conditions, the artificial dispersion of rain clouds, and the varying characteristics of the release led to a very complex pattern of atmospheric transport and deposition on the ground both within the Soviet Union and in other countries. Immediately after the initiation of the accident

the 45,000 inhabitants of Pripyat were warned to evacuate, and that protective measure was extended to the 90,000 persons living around Chernobyl (30 km radius). The medical teams checking the evacuees involved 1,240 physicians, 920 nurses, and more than 4,000 assistants. Besides the Russian people, 400 million European people received some dose of radiation (IAEA, 1986).

Goiania and surrounding area, Brazil, 1987. The accident began in September 1987 when a radiotherapy device was taken from a closed clinic in Goiania (population one million approximately) and sold as scrap to a junk dealer. When the capsule was sawn open, the 100g mass of luminescent material was very attractive, especially to children to whom it seemed a magical material and who began to play with it. That resulted in a significant dispersion of Cs on clothing, paper, walls, and floors, and also to internal overexposure in many individuals. Afterwards, those people began to show signs of radiation sickness, and the environment was severely contaminated. That accident demonstrated how a relatively minor accident involving a sealed source could result in a chain of events affecting an entire state's economy and disrupt social relations throughout a whole region (IAEA, 1988).

Accidents Resulting in High Doses to Few Individuals

Human exposures to high doses at high dose rates have occurred since the 1940s, at the beginning of the nuclear

epoch, involving various activities such as the use of radioactivity in industry, medicine, research, and the military, but fatal events were rare (Lushbaugh, 1989). The classification of radiological accidents can be useful to identify the events according to the various sources of exposure, such as criticality, sealed sources, and reactor accidents; a distinction should also be made between whole-body and localized exposures.

Criticality accidents. From 1945 to 1965 criticality in nuclear reactions has been responsible for the highest death rate among all radiation accidents: eight deaths, including three victims due to fatal blast injuries after the SL1 accident, Idaho Falls, Idaho, in 1961. Since 1965 a better knowledge and evaluation of criticality parameters, and the elaboration of calculation codes, has allowed the reduction of the number of situations leading to criticality states (Nenot, 1990).

Accidents resulting in high whole-body doses from sealed sources. Since the 1940s the number of reported deaths related to industrial and medical sealed sources is 28. Medical use was the cause of severe accidents in 10-20% of the cases, while industrial use, chiefly crystallography and gammagraphy, represented more than 60% (De Oliveira, 1987).

The first severe accident involving the general population was reported in Mexico in 1962, involving five

persons of whom only one survived, and the second one happened in mainland China in 1963, involving six individuals and resulting in two deaths. These two accidents were caused by the loss of Co sources. Another accident in the public sector happened in Algeria in 1978, where 22 individuals were overexposed by an Ir^{192} source. This accident resulted in the exposure of a whole family during a period of four to six weeks and caused one death (UNSCEAR, 1988). The Goiania accident (1987) previously described was certainly the most severe event related to a sealed source, and this accident caused the death of four people (IAEA, 1988). Accidents occurring at the workplace resulted in fewer victims. Examples are the lethal accidents that happened in Italy (1975) and in Norway (1982). The last accident that was reported happened in San Salvador (1989). In this accident, one worker died after six months, during which time his right leg had been amputated, and two other victims survived, although one had to have the left leg amputated (Nenot, 1990).

Nuclear power reactor accidents resulting in acute doses among the workforce. Up to the 1980s reactor accidents occurred only in research reactors with the exception of the Three Mile Island incident in 1979, which did not result in any ill health. The main accidents which caused death or acute exposure related to criticality accidents were (1) Vinca, Yugoslavia (1958), with eight

individuals overexposed; the accident resulted in one death, and five victims received the first bone marrow transplantation ever performed to treat radiation-induced aplasia; (2) Idaho Falls, Idaho, U.S.A. (1961), known as the SL1 accident, where an explosion killed three individuals; (3) Mol, Belgium (1965), where one victim survived but had his left leg amputated (Nenot, 1990).

The only accident in a nuclear power plant which can be classified as a catastrophic event was the Chernobyl accident in 1986. The Chernobyl accident illustrated the difficulties raised by the combined injuries. Many victims had radiation injuries related to Beta emitters deposited on skin and clothes, which severely complicated the acute bone marrow syndrome. The victims with these radiation injuries showed aplasia and skin lesions. In addition to aplasia, a significant number of patients developed gastrointestinal syndrome and lung impairment. Among the 18 individuals with the gastrointestinal syndrome, 7 had only moderate digestive symptoms but only 1 victim survived, and radiation pneumonitis was found in 13 patients, among whom 7 died (IAEA, 1986; UNSCEAR, 1988).

Accidents resulting in localized radiation injury. Accidental irradiation of relatively small parts of the body often involved only an extremity, or one or a few organs, because of localized distribution of the radiation beam. The skin and the underlying structures, especially of the

extremities, were the tissues most often affected by localized overexposure. Localized radiation injury, commonly skin lesions, may be isolated or associated with whole-body overexposure, as was the case, for instance, for some of the Marshallese population and Japanese fishermen, and for most of the highly exposed victims of the Chernobyl and Goiania accidents. When not combined with other injuries, localized irradiations may well not be recorded and may remain unknown, especially when doses are not high enough to result in very severe damage requiring amputation (Nenot, 1990).

Accidents resulting in severe internal exposure. In the workforce, internal contamination incidents were not uncommon but very rarely resulted in doses in excess of the limit. In the general population, internal contamination may occur, but most of the time at low doses; the Goiania accident was probably the only exception where high internal doses were delivered to large groups of the population. Nevertheless, over about 20 years, 11 fatalities have been reported due to internal contamination, and most of them originated from errors in medical administration (Nenot, 1990).

Control and Prevention of Nuclear Power Plant Accidents

Nuclear Reactors

There are many possible variations in the design and components of nuclear reactors in which the fission process

is used for the release of energy as heat. Nevertheless, all power reactors have certain features in common. The main reactor types are thermal reactors and fast reactors. In a fast reactor, the great majority of the fissions are caused by fast neutrons, whereas in a thermal reactor, most fissions result from the absorption of much slower neutrons. The reactor, surrounded by a shield, consists of a core, in which the fission chain is sustained and in which the fission energy is released as heat. The core contains nuclear fuel, usually in the form of long, thin cylindrical rods. The fuel rods or assemblies of rods are sometimes called fuel elements. The fissile species in a fuel element can be in the form of metal, but an oxide or carbide is commonly used because it can withstand much higher temperatures without melting. The fuel material is almost always enclosed by a thin metal cladding in order to both prevent the escape of fission products into the coolant used to remove the fission heat and protect the fuel from chemical attack by the coolant. In a thermal reactor, the core contains a moderator, the purpose of which is to decrease the speed of the fast neutrons that are liberated in the fission process. Fast reactors do not have a moderator as such; elements that might slow down the fission neutrons are avoided as far as possible, but some will be present in the oxide fuels commonly used (Glasstone, 1967). The core is surrounded by a neutron reflector. The purpose

of the reflector is to decrease the loss of neutrons that have escaped from the core. In the thermal power reactors, the reflector usually consists of the same materials that serve as the moderator. In fast reactors, the reflector is usually chemically similar to the fuel, but the uranium is not enriched in fissile material. The heat generated in the reactor core, as a result of the fissions occurring there, is removed by circulation of a suitable coolant. The coolant may be either a liquid or a gas. In power reactors in the United States that use water as the moderator (and reflector), the same water acts as the coolant. The water-cooled reactors have the advantage of using the same materials as coolant, moderator, and reflector. About reactor control, variations in a thermal reactors are achieved by inserting or withdrawing control rods containing a neutron poison, that is, a substance that can readily absorb neutrons. Among such poisons are the elements boron and cadium; control rods for thermal reactors usually contain one or the other of these elements in convenient form. To ensure the safety of nuclear power operators, the reactor is surrounded by biological shielding. The purpose of this shielding is to attenuate the neutrons and gamma rays escaping from the reactor to such an extent that the radiations do not constitute a hazard to persons in the immediate vicinity. Power reactors often have two different shields: a thermal shield and a biological shield. The

thermal shield, which is within the reactor vessel and is fairly close to the core, usually consists of a few inches of iron or steel. By absorbing much of the gamma radiation and some of the neutrons, the thermal shield protects the biological shield from possible damage due to overheating. It also protects the steel reactor vessel from embrittlement that could result from continuous bombardment by neutrons. The biological shield is generally a layer of concrete several feet thick surrounding the vessel containing the reactor core, reflector, and coolant. This shield attenuates neutrons and gamma rays that are not removed by the thermal shield. As a precaution against the possible spread of radioactive materials in the unlikely event the reactor core is damaged, the whole nuclear steam supply system is enclosed in a containment vessel made of reinforced concrete with a steel liner. This vessel, which is a characteristic feature of nuclear power plants, is designed to withstand the highest pressure that could be attained as the result of the worst credible accident with the particular reactor system (Glasstone & Jordan, 1980).

Defense in Depth of Nuclear Power Plants

The basic philosophy of the U.S Nuclear Regulatory Commission (NRC) in assuring safety in the design, construction, and operation of nuclear plants has been called "defense in depth," as expressed in terms of three levels of safety. The first level of safety is to design

the reactor and its associated components so that they will operate with a high degree of reliability with only a small chance of a malfunction occurring. To this end, the NRC's quality assurance program and the use of strict codes and standards place special emphasis on the quality of materials and workmanship in plant construction. The plant must be designed and constructed to withstand hurricanes, tornadoes, and other natural phenomena, and be capable of a safe shutdown in the event of the worst earthquake that might be expected at the plant site. Furthermore, the design must permit continuous or periodic monitoring of components and systems to detect signs of wear or incipient failure. Despite the assurance offered by careful plant design and construction, it is necessary to anticipate that some incidents or malfunctions will occur during the service life of the installation. The purpose of the second level of safety is to provide means that will forestall or cope with such events. The nuclear reactor consequently is equipped with a protection system designed to prevent, arrest, or accommodate safely a range of conceivable abnormal situations. Finally, the third level of safety is based on the view that it is prudent to go beyond the levels of safety described above and to incorporate additional systems and barriers to the escape of radioactivity to protect the public even if certain highly unlikely accidents should

occur (Chester, 1976; Cooper & Langer, 1976; Glasstone & Jordan, 1986).

Reactor Protection System

The purpose of the protection system is to detect abnormal conditions in the nuclear plant and to institute automatically whatever safety action is needed. The system receives signals from instruments that monitor the important plant process variables, such as the coolant water temperature, system pressure, power level, neutron flux, coolant flow rate, and so on. If the instruments indicate a transient that cannot be corrected immediately by adjustments, then the protection system must automatically cause the control rods to be rapidly inserted into the reactor core to terminate the fission chain (Glasstone & Jordan, 1986).

Licensing of Nuclear Power Plants

The safe design, construction, and operation of a commercial nuclear power plant are the responsibility of the owner-operator (or licensee) of the facility. The U.S. Nuclear Regulatory Commission (NRC), however, has the statutory responsibility for protecting the health and safety of the public (and the quality of the environment) in connection with the development and use of nuclear energy. This responsibility is implemented through the NRC's licensing and inspection procedures. These procedures are aimed at providing assurance that nuclear power plants can

be operated in a reliable manner without endangering the health and safety of the public (Goodrich, 1974; Hendrie, 1983).

Effects of External Variables on the Approval of Nuclear Power Energy

At the report of Fishbein and Ajzen (1975), a limited number of demographic characteristics and traditional variables were assessed. The demographic characteristics considered were the respondents' sex, age, and education. Additionally, given the political nature of the behavior under investigation, respondents were asked to indicate their party affiliations. The results of Fishbein showed that these variables were largely irrelevant to a person's voting decisions; neither sex nor age nor education could be used to predict whether a person would vote for or against the nuclear safeguards referendum. Party identification was found to be a somewhat better predictor, with Democrats and Independents more likely to vote "yes" than Republicans. Although the correlation was significant, it was of relatively low magnitude (r=.37).

Mass Media and Behavioral Intention Related to Nuclear Power Energy

Individuals report that they rely on the media for risk information (Freimuth, Edgar, Hammond, 1987; National Research Council, 1989), but the impact of that reliance has only been explored. Some researchers suggested that risk stories directly influence individuals' risk perceptions

(Johnson & Tevrsky, 1983; Mazur, 1981; Hawkes, Pilisuk, & Stiles, 1984), while others find little evidence of media influence (Tyler, 1984).

The studies that did find an impact suggested that media messages may influence both cognitive (what we know) and affective (how worried we are) responses to risk (Dunwoody & Neuwirth, 1987). However, there is a good deal of unhappiness within the technical community about the quality of reporting about nuclear power in both the printed and electronic media. This is due to mainly the fact that media reporters are required to meet unreasonable deadlines, having only a few hours to complete reports, and due to the fact that the reporters have little or no scientific training. Published letters to the editor are important sources of information for the public, but the major newspapers sometimes publish letters that are written by people who are very poorly informed. Many items discussing atomic energy in the mass media are factually wrong, and the subject of nuclear energy is entwined many times with the subject of nuclear war. The net effect of all the many ways in which biases creep into the handling of the news is that the public is seriously misinformed about the subject of nuclear power (Eisenbud, 1983). Even the massive content analysis of media coverage of Three Mile Island, which was part of the federal investigation of the accident, was designed in part to respond to the accusation that media

coverage of the accident created unnecessary public alarm by dwelling on the frightening, doomsday attributes of the events (Burger, 1984; Lawler, 1986).

In the research of Ryan, Dunwoody, Tankard (1991), closer examination of individual stories about the effect of the Ginna nuclear power plant accident in 1982 in trade magazines, popular science magazines, general magazines, and both prestige and more typical daily newspapers suggested that the variance may be attributable to differences in the way stories about the accident were framed by journalists. The study of Lichter, Rothman, Rycroft, and Lichter (1986) analyzed news coverage of nuclear energy at seven national media outlets from 1970 through 1983, including the New York Times, Time, Newsweek, U.S. News and World Report, and ABC, CBS, and NBC. The findings showed that media coverage emphasized the damages from nuclear energy.

Fishbein's Model of Reasoned Action and Nuclear Power Plants

Fishbein's Model

Fishbein's model of reasoned action (Figure 2) was the theoretical basis of this study. According to this theory, a person's behavior is assumed to be a function of his behavioral intention, which in turn is a function of attitudes toward the behavior and subjective norms regarding the behavior. The theory may be expressed symbolically by the following equation:

$$B \cong BI = (Ab)W1 + (SN)W2$$

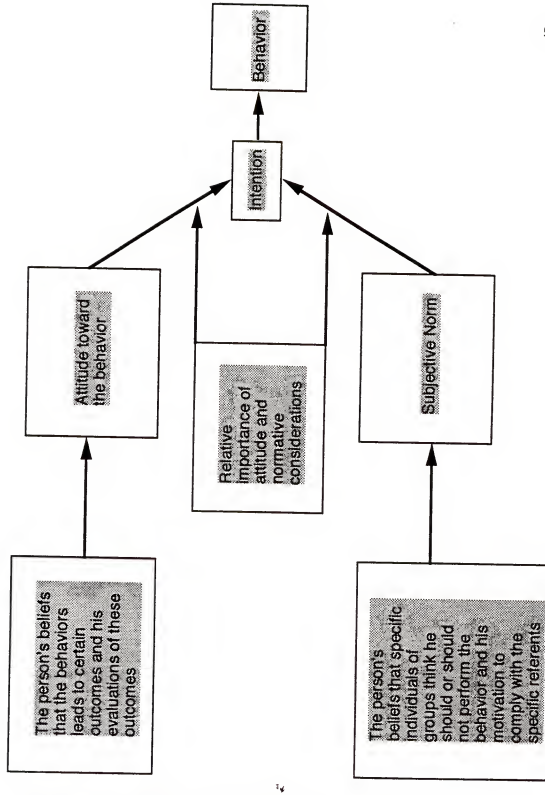
Behavior
Intention
Attitude toward the behavior
Relative importance of attitude and normative considerations
Subjective Norm
The person's beliefs that the behaviors leads to certain outcomes and his evaluations of these outcomes
The person's beliefs that specific individuals of groups think he should or should not perform the behavior and his motivation to comply with the specific referents

Figure 2. Factors Determining A Person's Behavior.
Note: Arrows indicate the direction of influence.
Source: Ajzen & Fishbein, 1980

where

B = the behavior in question,

BI = behavioral intention,

Ab = the attitude toward the behavior,

SN = subjective norm, and

W1 and W2 are empirically determined regression weights which are indicative of the importance of the attitudinal and normative components in predicting intentions.

The attitudinal component of the model (Ab) has consistently been shown to be highly related to an individual's beliefs that the behavior in question will lead to certain consequences, weighted by his evaluations of those consequences. It can be expressed as follows:

$$Ab = \Sigma\ Bi*Ei$$

where

Ab = the attitude toward the behavior

B = the beliefs that performing the behavior will lead to consequence i

E = the person's evaluations of consequence i

The subjective norm component of the model (SN) has been shown to be related to the individual's normative beliefs about what significant others think he should do or should not do, weighted by his motivations to comply with these others. The relationship may be expressed as follows:

$$SN = \Sigma\ NBi*MCi$$

where

SN = subjective norm

NB = the normative beliefs that a given other (referent i) thinks one should or should not perform the behavior

MC = the person's motivations to comply with referent i (Ajzen & Fishbein, 1980; Bowman & Fishbein, 1978).

Studies Regarding Nuclear Power Plants with Fishbein's Model

Fishbein's model of reasoned action has been applied to many research studies that have investigated health-related behaviors. The major issues have included marijuana use (Bearden & Woodside, 1978; Pomazal & Brown, 1977), alcohol use (Schlegel, Crawford, Sanborn, 1977; London, 1982; Roberts, Chval, & Dunlop, 1977; Budd & Spencer, 1984), consumer behavior (Ryan & Bonfield, 1975; Fishbein & Ajzen, 1980), exercise (Godin & Shephard, 1984; Godin, Colantonio, Davis, Shephard, and Simard, 1986), cigarette smoking (Page, 1982; Sherman, 1983; Beck & Davis, 1980; Budd, 1986; Dratt, 1986; Grube, Morgan, McGree, 1986; Hernandez-Ramos, 1985; Presson, 1984; Chassin, Presson, Sherman, Corty, Olshavsky, 1984; Loken, 1982; Sherman et al., 1982; Rausch, 1985; Peers & Christie, 1984; Chen, 1985), smokeless tobacco use (Brubaker & Loftin, 1987), quit smoking (Lyon, 1982), blood donor (Pomazal & Jaccard, 1976; Ahlering, 1979; Hsiao, 1988), health risk (O'Rourke, Smith, & Nottle, 1984), premarital sexual intercourse (Ajzen & Fishbein, 1972, 1973; Yang, 1992), contraceptive behavior (Jorgensen & Sonstegard,

1984; Adler, 1987; McLittle, 1985), weight loss (Sejwacz, 1977; Yang, 1991), family planning behaviors (Fishbein, Jaccard, Davidson, Ajzen, & Loken, 1980). Those studies, as mentioned by London (1982), significantly support the model's ability to predict behavioral intentions and to provide a better understanding of the attitudinal and subjective normative correlates of specific behaviors.

In the study of Bowman and Fishbein (1978), the Fishbein attitude model was applied to voter decision-making on an energy ballot proposal. In the first stage of the study, elicitation interviews were conducted over the telephone with 17 potential voters in Colorado and 19 potential voters in Oregon; telephone numbers were randomly selected from directories for Denver, Colorado, Eugene, Oregon, and Portland, Oregon. The interviews were designed to assess voter awareness of the nuclear power proposals, to elicit salient beliefs held about the nuclear power proposals, and to elicit names of people and groups whose viewpoints were most salient in order to obtain lists of the most frequently mentioned beliefs about consequences and of the most frequently mentioned referents. However, because of the lack of firm public opinion on the issue, it was decided to supplement the information gained from elicitation interviews with that from newspaper items and the campaign literature concerning the Oregon nuclear ballot proposal. The content analysis of these materials yielded

lists of 20 consequences and 7 referents for use in the final questionnaire. Afterwards, the questionnaires were sent to a random sample of potential voters in Oregon's 1976 general election and dealt with the Nuclear Safeguards Initiative, a measure that would place restrictions on future nuclear power plants. The questionnaire items probed the attitude toward the act of voting "yes" on the measure (Aact), perceived likelihood of various consequences of voting "yes" (Bi), evaluations of these consequences (Ei), the subjective norm (SN), normative beliefs (NBi), motivations to comply with several referents (MCi), and voting intention (VI). A follow-up interview determined the actual voting behavior (VB) of persons responding to the questionnaire. The following model predictions were tested and strongly supported by the data: (a) VB = VI; (b) VI = (Aact)W1 + (SN)W2; (c) Aact = Σ Bi*Ei; (d) SN = Σ NBi*MCi; and (e) external variables have a nonsignificant relationship to VB once VI is partialled out. It was concluded that the Fishbein model should be extremely useful in understanding public reaction to future energy proposals.

The study of Hughey (1981) investigated attitudes, beliefs, and evaluations of beliefs over time of residents living in the host community for a nuclear power plant. Hypotheses were derived from the model of attitudes developed by Fishbein. A survey was conducted among residents of the town of Hartsville and Trousdale County,

population 5,500, located in middle Tennessee. Residents (N = 217) who were interviewed in 1975 as part of an earlier survey were reinterviewed for this survey. General attitude toward the plant was taken to mean the degree to which respondents would allow construction of the plant and also the proximity to their homes they would tolerate construction. Beliefs and evaluations of beliefs were assessed in reference to the perceived likelihood of 27 potential outcomes associated with the plant. The results showed that there had been a sizable negative change of attitude toward the plant. Positive outcomes such as economic growth were believed to be much less likely in 1980 than in 1975. Beliefs concerning the likelihood of negative outcomes such as crowding in schools and sabotage were mixed. Changes in evaluations of beliefs were smaller than changes in beliefs. The basic Fishbein's model was a significant predictor of attitudes toward the plant in both 1975 and 1980, although better in 1975. Three groups of outcomes (hazards, economic growth, and social disruption) were consistently the best predictors of attitude toward the plant. The findings were consistent with Fishbein's model and have implications for studies of the social impacts of large-scale public projects. One study by Otway and Fishbein (1977) also showed that beliefs and evaluations could be used to accurately predict attitudes toward nuclear power in general, and Sundstrom et al. (1977a), and

Sundstrom, Lounsbury, DeVault, & Peelle (1981) showed that beliefs could predict attitudes toward the Hartsville plant.

Generally speaking, the results of most research studies in which the Fishbein's model has been applied have shown that the estimates of attitudes and normative factors can be used to meaningfully predict behavior intention. Indeed, Fishbein's model is an invaluable approach to educational diagnosis and program planning, especially in the fields of health behavior for preventing diseases and nuclear power plants.

Measurement of the Nuclear Power Plant Attitude-Behavior Relationships with Nuclear Locus of Control

A considerable body of literature implicated the perception of causality, or locus of control, as an important mediator of responses in many situations. Rotter (1966) popularized the construct of locus of control with his development of a 23-item Internal-External (I-E) Control Scale. Rotter's locus of control concept, embedded in his social learning theory, was conceptualized as an expectancy to receive reinforcement either as contingent upon one's own behavior (internal) or as the result of forces beyond one's control (external). In 1973, Levenson developed the I, P, and C Scales, which measured internal, powerful others, and chance locus of control. Wallston, Wallston, and Devellis (1978) used Levenson's locus of control concepts as the basis for the development of their Multidimensional Health Locus of Control (MHLC) Scales, with three scales measuring

internal, powerful others, and chance locus of control over health concerns.

With respect to issues of nuclear war, Erdahl and Rounds (1986) have developed a measure of nuclear locus of control. Since the separation of external control into powerful others and chance seemed especially appropriate to the study of nuclear issues, the nuclear locus of control (NLOC) scales were based on Levenson's tripartite model. Scales were developed from a 72-item pool to assess beliefs that control over the possibility of nuclear war and nuclear policy decisions was within one's own control, the control of powerful others, or simply left to chance or fate. Factor analytic procedures lead to the development of two equivalent 6-item forms for each scale: internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC). Items were responded to on a six-point Likert-type format ranging from "strongly disagree" to "strongly agree," with high scores on all scales reflecting high expectations of control for the respective construct, e.g., powerful others. Results showed alpha coefficients for the six-item NLOC scales ranging from .83 to .93.

Locus of control of nuclear war have been proposed as important variables in understanding nuclear attitude-behavior relationships (McClenney & Neiss, 1984; Pavelchak & Schofield, 1984; Tyler & McGraw, 1983). According to

research, people usually showed the emotional impact from nuclear war when they mentioned nuclear power plants (Klineberg, 1984; Wagner, 1985; Dohrenwend et al., 1980), and the mass media's inappropriate reports made people more concerned about the relationships between nuclear power plants and nuclear war (Lichter et al., 1986). Therefore, nuclear locus of control is an important variable in understanding the attitude-behavior relationships for nuclear power plants.

Summary

This chapter reviewed 1) health concerns of radioactive materials and nuclear power plants, 2) socioeconomic concerns of nuclear power and related radioactive events, 3) control and prevention of nuclear power plant accidents, 4) effects of external variables on the approval of nuclear power energy, 5) mass media and behavioral intention related to nuclear power energy, (6) Fishbein's model of reasoned action and nuclear power plants, (7) measurement of the attitude-behavior relationships about nuclear power plants with nuclear locus of control.

The review is summarized as follows:

1. The discovery of x-rays by Roentgen has given great benefits to medical therapy for human health; at the same time, the radiations from x-rays or other radioactive materials have caused considerable current controversy for human health. Although high-level exposure to radiation may

cause serious adverse effects on health, there are controversial arguments about health concerning low-dose exposure. Many researchers supported that low-dose exposure could cause leukemia and cancers, but many others reported that there were no relationships between low-dose exposure and leukemia, cancers, or other diseases.

2. Although many nuclear experts reported how safe the nuclear power plant were, there were several nuclear power plant accidents, such as those at Three Mile Island and Chernobyl. The Chernobyl accident was the worst accident since the beginning of nuclear power plants. Many researchers indicated that nuclear power plants could make people sick--leukemia, cancers, malignant tumors, and so on. However, many other research showed that there were not any relationships between nuclear power plants and diseases.

3. Most of research showed that the main health effect of accidents of nuclear power plants was the impact of the associated psychological problems, such as stress, anger, fear, extreme worry and upset, emotional disturbances, anxiety, and so forth. Workers at nuclear power plant accident sites also showed lower job satisfaction, much greater uncertainty about their job future, greater job tension, lower occupational self-esteem, demoralization, and even psychophysiological symptoms. However, a few reports showed that nuclear power became less feared after the

accident at Chernobyl, and these results deserve further examination.

4. There were two types of nuclear accidents: (1) events that involved large groups of the population, and (2) events that involved only a limited number of individuals with high-dose exposure. Events of the first type were relatively rare and only seven accidents deserved to be reported. On the other hand, many events of second type of nuclear accident were not reported, especially when they did not result in severe consequences. This type of exposure has occurred since the 1940s, at the beginning of the nuclear epoch, involving various activities such as the use of radioactivity in industry, medicine, research, and the military, and the fatal events were rare. However, the Chernobyl accident in 1986 was classified as a catastrophic event.

5. Nuclear plants are massive structures with multiple barriers against the accidental release of radioactive materials. They are designed to resist very large earthquakes, flooding, tornados, hurricanes, and windstorms with whatever missiles might be driven by these storms. They are also designed to resist all manner of major component failures and breakdowns, including a complete rupture of the largest pipe in the reactor primary system. The various systems essential to safety, the shutdown systems, systems for keeping the core covered with water,

and systems for removing afterheat, as well as the emergency electrical power systems that provide motive power to them, are all arranged with redundant, parallel subsystems so that component failures or operator errors that might disable one section of a safety system will not prevent the safety function from being carried out. The plants are built to conform to rigorous government regulations and engineering codes and standards. There are requirements for extensive quality assurance programs in all aspects of construction and operation. Nuclear plant operations are monitored by federal government inspection personnel, with inspectors stationed permanently at each site as well as regular visitations by inspectors and experts from regional and national headquarters. Plant operations are also audited by the industry-supported Institute of Nuclear Power Operations.

6. In the study of Fishbein, neither sex nor age nor education as demographic variables could be used to predict whether a person would vote for or against the nuclear safeguards referendum. Party identification was found to be a somewhat better predictor, but the significant correlation was relatively low (r=.37).

7. Many people reported that they rely on the media for risk information, and media messages may influence both cognitive and affective response to risk for people. Because of a lack of time for preparing the news and

unqualified reporters or editors, the media coverage of nuclear accidents has usually created unnecessary public alarm by dwelling on the frightening, doomsday attribute of the event.

8. According to Fishbein's model of reasoned action, a person's behavior is assumed to be a function of his behavioral intention, which in turn is a function of attitudes toward the behavior, and subjective norms regarding the behavior. The attitudinal component of this model (Ab) has consistently highly related to an individual's beliefs that the behavior in question will lead to certain consequences, weighted by his evaluations of those consequences. The subjective norm component of this model (SN) is related to the individual's normative beliefs about what significant others think he should or should not do, weighted by his motivations to comply with these others.

9. Fishbein's model of reasoned action has not only successfully been applied to many research studies that have investigated health-related behaviors, but several studies also indicated that this model can adequately predict behavioral intention and behavior of response to nuclear power plants.

10. A considerable body of literature implicated the perception of causality, or locus of control, as an important mediator of responses in many situations. With respect to issues of nuclear war, Erdahl & Rounds (1986)

developed a measure of nuclear locus of control which included internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC). Nuclear locus of control have been proposed as important variables in understanding nuclear attitude-behavior relationships. Because of the fear of nuclear war and inappropriate reports by mass media, there were some close relationships between nuclear power plants and nuclear war in general. Therefore, this variable of nuclear locus of control is added to Fishbein's model of this study to predict attitude, subjective norm, and behavioral intention toward the proposal of new nuclear power plants in Taiwan, R.O.C.

CHAPTER III
METHODOLOGY

The purpose of this study was to identify the beliefs about and evaluations of behavioral outcomes, attitude, and social factors toward proposed nuclear power plants. Furthermore, the purpose of the study was to predict the behavioral intention toward the proposal of new nuclear power plants through the beliefs about and evaluations of behavioral outcomes, attitude, subjective norm, normative beliefs of important others, and motivations to comply with important others for reacting new nuclear power plants. This section contains 1) subjects, 2) sampling procedure and data collection, 3) instrument, and 4) analysis of data.

Subjects

Subjects for this study were first-year students in the three teacher-training universities in Taiwan, National Taiwan Normal University, National Chang-Hua Educational University, and National Kaohsiung Normal University. These students had just completed their high school education and passed the national university entrance examination. In general, they were not different from first-year students in other universities except that teacher preparation was their choice of university. There were 2,319 first-year students enrolled at these three universities during fall semester in

1992. Subjects in the study were randomly selected from all first-year students enrolled during that semester by cluster sampling. The sample was comprised of 315 males and 459 females with an average age of 19.36 years (SD=1.38). The breakdown of the subjects according to universities is presented in Table 1.

Table 1. Number of Subjects at Universities

Univ.	Total Class	Sample Class	Sample Student	Complete Survey
Taiwan	40	14	456	447
Chang-Hua	15	5	216	200
Kaohsiung	12	4	134	127
Total	67	23	806	774

Sampling Procedure and Data Collection

Cluster sampling was used to select the sample. A class was the sampling unit. After selection of the subjects, professors of each of the sampled classes were contacted by telephone to get permission to use classroom time for survey administration. In order to be consistent, the researcher administered all surveys under the assistance of the professor who was responsible for the class at the time of the survey. It took 20-25 minutes for subjects to complete the survey.

Instrumentation

Because there was no standardized survey instruments related to voting regarding new nuclear power plants

available in Taiwan and because of the many social and cultural differences between Taiwan and other countries, the questionnaire for this study was adopted and modified from the one designed by Bowman and Fishbein (1978). This study also adopted the Nuclear Locus of Control Scales developed by Erdahl and Rounds (1986) with some modifications. These questionnaires were used to collect the data.

Open-Ended Elicitation Questionnaire

An open-ended elicitation questionnaire was used with some modification in order to obtain a set of salient beliefs and social referents concerning the proposal of new nuclear power plants. An elicitation questionnaire (Appendix A) was given to an independent sample of 165 students at three teacher-training universities. The instrument asked the students to list their beliefs about the perceived advantages and disadvantages of voting "yes" for building new nuclear power plants and to indicate those individuals or groups of individuals who would be concerned with their behavioral intention for voting to build new nuclear power plants.

Closed-Format Questionnaire

After completing the elicitation survey, a closed-format questionnaire from the study of Fishbein (1978) was modified based on the most frequently mentioned beliefs and social referents by the independent sample. There were 51 items in the questionnaire. Beliefs about the consequences

of voting "yes" for building new nuclear power plants, the evaluations of the consequences, and the normative beliefs, motivations to comply, attitude, subjective norm, and behavioral intention were measured by single, seven-point, bipolar adjective scales which were similar to the instruments developed by Bowman and Fishbein (1978). Beliefs about the consequences of voting "yes" for building new nuclear power plants were measured on Likert-type scales with a range from "likely" to "unlikely," while evaluations of the consequences of voting had Likert-type scales ranging from "good" to "bad." Measurement of normative belief utilized Likert-type scales of "I should" to "I should not" and motivations to comply was measured with "I want to do" to "I don't want to do" as the scales. All scales were weighted from +3 (for extremely likely, extremely good, I should, and I want to do) to -3 (for extremely unlikely, extremely bad, I should not, and I don't want to do). The middle or zero point on the scale was interpreted as a neutral response, and it was treated as nonagreement with either member of the adjective pair.

Although it was the first time this kind of research instrument was adopted from that of Fishbein and modified for the students at teacher-training universities in Taiwan, there was good content validity. In order to determine the internal consistency reliability of the survey instrument, a pilot study with an independent sample of 120 students at

teacher-training universities was conducted. The Cronbach's alphas (α) for beliefs, evaluations, attitude, normative beliefs, motivations to comply, and subjective norm were .71, .73, .91, .60, .69, and .90, respectively, which meant that the internal consistency of the instrument was high.

Based on the results of reliability testing and the recommendations provided by some advisors, the final closed-format questionnaire was completed (Appendix B). There are 9 single-response items for demographic characteristics which included age, gender, university, academic major, parental socioeconomic status, residence, and party affiliation. Of the other single-response items, 10 measured beliefs about the consequences of voting "yes" for building new nuclear power plants, and 10 measured corresponding evaluations of the consequences. Also, 8 scales measured normative beliefs and 8 measured motivations to comply with the social referents. Examples of the type of questions were as follows:

Behavioral intention (BI)

I intend to vote "yes" on the proposal of new nuclear power plants.

Likely ___:___:___:___:___:___:___ Unlikely

Attitude toward the behavior (Ab)

My voting "yes" on the proposal of new nuclear power plants would be

Good ___:___:___:___:___:___:___ Bad

Wise ___:___:___:___:___:___:___ Foolish

Beneficial ___:___:___:___:___:___:___ Harmful

Beliefs (Bi)

My voting "yes" on the proposal of new nuclear power plants would ensure low-cost electricity.

Likely ___:___:___:___:___:___:___ Unlikely

Evaluations of beliefs (Ei)

Ensuring low-cost electricity would be

Good ___:___:___:___:___:___:___ Bad

Subjective norm (SN)

Most people who are important to me think I should vote "yes" on the proposal of new nuclear power plants.

Likely ___:___:___:___:___:___:___ Unlikely

Normative beliefs (NBi)

Most members of my family think I should vote "yes" on the proposal of new nuclear power plants.

Likely ___:___:___:___:___:___:___ Unlikely

Motivations to comply (MCi)

Generally speaking, I want to do what most members of my family think I should do.

Likely ___:___:___:___:___:___:___ Unlikely

The following is an example of scoring for each question:

I intend to vote "yes" on the proposal of new nuclear power plants.

Likely								Unlikely
	extre-mely	quite	slig-htly	neit-her	sligh-tly	quite	extre-mely	

Nuclear Locus of Control Questionnaire

This study adopted and modified the Nuclear Locus of Control Scale (NLOC) developed by Erdahl and Rounds (1986), which contains three parts: internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC) (Appendix B). Each of these three in the study contained six items. All scales were weighted from +5 (for extremely agree) to +1 (for extremely disagree). The Cronbach's alphas (α) for these three parts were .71, .61, .66, respectively.

Analysis of Data

The data collected from the sample were analyzed by the statistical package SPSS/PC+. All data were summarized and presented in composite form.

Frequency distributions were used to describe demographic characteristics and political party affiliations. Based on the Fishbein study (1978) the following methods were utilized:

1. One-way analysis of variance (one-way ANOVA) and Hotelling's T^2 of one-way multivariate analysis of variance (one-way MANOVA) (Lin, 1986) were used to determine if significant differences existed between proponents and opponents, among demographic variables, and among nuclear locus of control on the subcomponents

of the model (beliefs, evaluations, normative beliefs, motivations to comply, attitude, and subjective norm).

2. Behavioral intention was regressed onto the attitudinal and normative components of the model to test the predictive ability of the equation.
3. Pearson product-moment correlation coefficients (r) were used to determine the relationship between the primary subcomponents of the model (Ab and SN) and their respective determinants ($\Sigma BiEi$ and $\Sigma NBi(MC)i$).

CHAPTER IV
RESULTS AND DISCUSSION

Results

This study assessed the beliefs and evaluations of outcomes, attitude, normative beliefs of important referents, motivations to comply with important referents, subjective norm, behavioral intention, and the relationships of these variables to the proposal of new nuclear power plants. In addition, the relationships of these variables with external variables (demographic variables and nuclear locus of control) were investigated. This study also attempted to utilize Fishbein's model of reasoned action to investigate the relationships among subcomponents of Fishbein's model and to predict behavioral intention for voting in favor of building new nuclear power plants.

Sociodemographic Distribution of Subjects

A total of 774 students in 23 first-year teaching classes from three teacher-training universities were selected for the present study (Table 2). The number of students sampled from Taipei, Chang-Hua, and Kaohsiung were 447 (57.8%), 200 (25.8%), and 127 (16.4%), respectively. Ages of the sample ranged from 15 to 31, but a majority of students were 18 to 20 years of age. The sample consisted of 33.4% of the total first-year student population (N =

Table 2. Frequencies and Percentages of Sociodemographic Variables

Variables		Frequency	Percent
UNIVERSITY			
Taiwan		447	57.8
Chang-Hua		200	25.8
Kaohsiung		127	16.4
	TOTAL	774	100.0
GENDER			
Male		315	40.7
Female		459	59.3
	TOTAL	774	100.0
PARENT'S EDUCATIONAL STATUS	(Father)		
Graduate school		25	3.2
College/University		187	24.2
High school		304	39.3
Elementary school		248	32.0
Illiterate		10	1.3
	TOTAL	774	100.0
PARENT'S EDUCATIONAL STATUS	(Mother)		
Graduate school		3	.4
College/University		96	12.4
High school		242	31.3
Elementary school		388	50.1
Illiterate		45	5.8
	TOTAL	774	100.0
PARENT'S OCCUPATIONAL STATUS	(Father)		
Professional		155	20.0
Semiprofessional		266	34.4
Technical		149	19.3
Semitechnical		170	22.0
Nontechnical		34	4.4
	TOTAL	774	100.0
PARENT'S OCCUPATIONAL STATUS	(Mother)		
Professional		9	1.2
Semiprofessional		80	10.3
Technical		48	6.2
Semitechnical		170	22.0
Nontechnical		467	60.3
	TOTAL	774	100.0

Table 2. Cont'd.

POLITICAL PARTY AFFILIATION		
Current ruling party-Kuomintang (KMT)	173	22.4
Opposition party-Democratic Progressive Party (DPP)	40	5.2
Other*	561	72.4
TOTAL	774	100.0
RESIDENCE I		
Close to nuclear power plant	110	14.2
Not close to nuclear power plant	664	85.8
TOTAL	774	100.0
RESIDENCE II		
Industrial pollution area	120	15.5
Nonindustrial pollution area	590	76.2
Unknown	64	8.3
TOTAL	774	100.0
AGE (Years)		
15	1	.1
18	150	19.4
19	383	49.5
20	174	22.5
21	20	2.6
22	9	1.2
23	15	1.9
24	12	1.6
25	6	.8
26	2	.3
27	1	.1
31	1	.1
TOTAL	774	100.0

*Other: other parties and no party affiliation

2,319) in the three teacher-training universities. The first-year student population consisted of 26.6% of the entire student population of the three teacher-training universities (N = 8,722). The proportion of the males (40.7%) and females (59.3%) of the sample was similar to that of the first-year student population (male, 41.5%; female, 58.5%). The political party affiliation of a majority (72.4%) of the student population was with other parties or no party affiliation. Table 2 summarized the frequencies and percentages of the sociodemographic distribution.

Behavioral Intention, Attitude, Subjective Norm, and the Relationships Among These Variables

According to the theory of reasoned action (Ajzen & Fishbein, 1980), intention was the immediate determinant of behavior, and both attitudes and subjective norm were regarded as primary determinants of a person's responses to an object. Therefore, the study intended to describe behavioral intention, attitude, and subjective norm, and to investigate the behavioral intention of voting in favor of the proposal of new nuclear power plants from the attitude and subjective norm toward new nuclear power plants.

Behavioral Intention

Results of behavioral intention toward voting "yes" for building new nuclear power plants are summarized in Table 3. The scale range of behavioral intention is from +3 to -3; positive score indicated subjects are more likely to vote

Table 3. Frequencies, Percentages, and Mean Scores on Behavioral Intention Toward Voting "Yes" for Building New Nuclear Power Plants

Behavioral Intention	Positive		Zero		Negative		Mean	SD
	n	%	n	%	n	%		
Likely-Unlikely	485	62.6	53	6.8	236	30.6	.413	1.812

Scales range from +3 to -3
Positive score: likely to vote "yes"
Zero score: neutral
Negative score: likely to vote "no"

Table 4. Frequencies, Percentages, and Mean Scores on Attitude Toward Voting "Yes" for Building New Nuclear Power Plants

Attitude	Positive		Zero		Negative		Mean	SD
	n	%	n	%	n	%		
Good-Bad	413	53.3	136	17.6	225	29.1	.274	1.614
Wise-Foolish	429	55.4	136	17.6	209	27.0	.413	1.600
Beneficial-Harmf.	428	55.4	146	18.9	200	25.8	.386	1.576

Scales range from +3 to -3
Positive score: good, wise, beneficial
Zero score: neutral
Negative score: bad, foolish, harmful

"yes" for nuclear power plants. On the other hand, negative score indicated subjects are more likely to vote "no." The percentage of positive and negative scores was 62.6% and 30.6%, respectively, and the mean score was .413 (SD=1.812).

Attitude

Results of attitude toward the proposal of new nuclear power plants are summarized in Table 4. The scale range of attitude is from +3 to -3; positive score contains +3, +2, and +1, and negative score -1, -2, and -3. The percentage of attitude scores was 53.3% for "good" and 55.4% for both "wise" and "beneficial"; the percentage of attitude scores was 29.1% for "bad," 27.0% for "foolish," and 25.8% for "harmful"; the percentage of neutral attitude was only 17.6% for both "good-bad" and "wise-foolish," and 18% for "beneficial-harmful." The mean score was .274 (SD=1.614) for "good-bad," .413 (SD=1.600) for "wise-foolish," and .386 (SD=1.576) for "beneficial-harmful."

Subjective Norm

From Table 5, the percentages of important referents were 48.2% for "likely" and 45.2% for "support" subjects to vote "yes"; the percentages of important referents were 34.0% for "unlikely" and 29.1% for "oppose"; the percentages of neutrality of "likely-unlikely" and "support-oppose" were 17.8% and 25.7%, respectively. At the same time, the mean scores of "likely-unlikely" and "support-oppose" were .035 (SD=1.563) and .039 (SD=1.450), respectively. There also

were some percentages of neutrality for "likely-unlikely" (17.8%) and for "support-oppose" (25.7%).

Relationships Among Behavioral Intention, Attitude, and Subjective Norm

According to Table 6, the correlation coefficient between behavioral intention and attitude was significantly high (r=.8519**), and significant correlations also were found between behavioral intention and subjective norm (r=.7760**) and between attitude and subjective norm (r=.7639**).

Further analysis by using the following standard multiple regression equation for behavioral intention (BI), attitude (Ab), and subjective norm (SN) indicated that both attitude and subjective norm accounted for 76.34% of the variance of behavioral intention for voting "yes" (R=.8737, R^2=.7634, P<.01). In addition, attitude scores were better than subjective norm scores in predicting the behavioral intention (βAb=.6223, βSN=.3006) (see Table 7).

Attitude, Beliefs of Outcomes, Evaluations of Outcomes, and the Relationships Among these Variables

A person's attitude toward a behavior is determined by his salient beliefs that performing the behavior leads to certain outcomes and by his evaluations of these outcomes (Ajzen & Fishbein, 1980). Therefore, the study examined attitude, beliefs of outcomes, and evaluations of outcomes, and investigated the relationship among these variables.

Table 5. Frequencies, Percentages, and Mean Scores on Subjective Norm Toward Voting "Yes" for Building New Nuclear Power Plants

Subjective Norm	Positive		Zero		Negative		Mean	SD
	n	%	n	%	n	%		
Likely-Unlikely	373	48.2	138	17.8	263	34.0	.035	1.563
Support-Oppose	350	45.2	199	25.7	225	29.1	.039	1.450

Scales range from +3 to -3
Positive score: likely, support
Zero score: neutral
Negative score: unlikely, oppose

Table 6. Pearson Product-Moment Correlation for the Relationships Among Behavioral Intention (BI), Attitude (Ab), and Subjective Norm (SN) Toward Voting "Yes" for Building New Nuclear Power Plants

	BI	Ab	SN
BI	1.0000		
Ab	.8519**	1.0000	
SN	.7760**	.7639**	1.0000

** P<.01

Table 7. Multiple Regression Analysis of Behavioral Intention (BI) by Attitude (Ab) and Subjective Norm (SN)

Dependent	Independent	B[1]	Beta[2]	R	R^2	F
BI	Ab	.7700	.6223	.8737	.7634	1243.57**
	SN	.3789	.3006			

[1]B: regression coefficient (slope)
[2]Beta: standardized regression coefficient
** P<.01

Beliefs of Outcomes

Results of beliefs of voting "yes" to build new nuclear power plants are summarized in Table 8. Sixty-seven percent of the subjects thought that voting "yes" for new nuclear power plants would urge the government to develop new tests of nuclear safety systems; only 18.9% of the subjects did not think so; the mean score of this item was .599 (SD=1.219). Forty percent of the subjects indicated that voting "yes" would increase public participation in nuclear decisions; on the other hand, 42.7% of the subjects did not agree with this belief; the mean score of this item was -.078 (SD=1.289). Over half of the subjects (55.0%) said that voting "yes" would ensure low-cost electricity, and 29.1 percent of the subjects did not agree; the mean score of this item was .394 (SD=1.408). Most subjects (87.7%) indicated that voting "yes" would help economic development, and the mean score of this item was 1.337 (SD=1.017). Forty-three percent of the subjects thought that voting "yes" would solve the problem of future energy shortages, and 39.8% of the subjects did not think so; the mean score of this item was .031 (SD=1.465). Most subjects (89.4%) indicated that voting "yes" would increase the danger from radioactive materials and wastes, and the mean score of this item was 1.530 (SD=1.140). A total of 90.2% of the subjects expressed that voting "yes" would arouse the threat of catastrophe, and the mean score of this item was 1.486

Table 8. Frequencies, Percentages, and Mean Scores on Beliefs of Voting "Yes" for Building New Nuclear Power Plants

Consequences	Likely		Neutral		Unlikely		Mean	SD
	n	%	n	%	n	%		
Urge government to develop new safe systems of tests	519	67.1	109	14.1	146	18.9	.599	1.219
Increase public participation in nuclear decisions	310	40.0	134	17.3	330	42.7	-.078	1.289
Ensure low-cost electricity	426	55.0	123	15.9	225	29.1	.394	1.408
Help economic development	679	87.7	55	7.1	40	5.2	1.377	1.017
Solve future energy shortages	338	43.7	128	16.5	308	39.8	.031	1.465
Increase danger from radioactive materials, wastes	692	89.4	40	5.2	42	5.4	1.530	1.140
Arouse threat of catastrophe	698	90.2	22	2.8	54	7.0	1.486	1.138
Cause destruction of ecological environment	682	88.1	42	5.4	50	6.5	1.516	1.172
Result in more nuclear plants	496	64.1	142	18.3	136	17.6	.738	1.292
Increase threat of nuclear theft and sabotage	446	57.6	154	19.9	174	22.5	.615	1.286

Scales range from +3 to -3
Likely: +3 +2 +1
Neutral: 0
Unlikely: -1 -2 -3

(SD=1.138). Eighty-eight percent of the subjects said that voting "yes" would cause the destruction of the ecological environment, and the mean score of this item was 1.516 (SD=1.172). Over half of the subjects (64.1%) expressed that voting "yes" would result in more new nuclear power plants; the mean score of this item was .738 (SD=1.292). Fifty-seven percent of the subjects indicated that voting "yes" would increase the threat of nuclear theft and sabotage; on the other hand, 22.5% of the subjects did not agree; the mean score of this item was .615 (SD=1.286). Attention also must be given to the percentage of subjects with neutral beliefs. The percentages are 14.1% for "urge the government to develop new tests of nuclear safety systems," 17.3% for "increase public participation in nuclear decisions," 15.9% for "ensure low-cost electricity," 16.5% for "solve the problem of future energy shortages," 18.3% for "result in more new nuclear power plants," and 19.9% for "increase the threat of nuclear theft and sabotage."

Evaluation of Outcomes

Results of evaluations of voting "yes" to build new nuclear power plants are summarized in Table 9. Over half of the subjects (65.1%) favorably evaluated that voting "yes" for new nuclear power plants would urge the government to develop new tests of nuclear safety systems, and 24.2 percent of the subjects did not; the mean score of this item

Table 9. Frequencies, Percentages, and Mean Scores on Evaluations of Voting "Yes" for Building New Nuclear Power Plants

Consequences	Good		Neutral		Bad		Mean	SD
	n	%	n	%	n	%		
Urge government to develop new safe systems of tests	504	65.1	83	10.7	187	24.2	.517	1.374
Increase public participation in nuclear decisions	365	47.2	86	11.1	323	41.7	.044	1.434
Ensure low-cost electricity	422	54.5	100	12.9	252	32.6	.373	1.423
Help economic development	667	86.2	42	5.4	65	8.4	1.209	1.102
Solve future energy shortages	238	30.7	85	11.0	451	58.3	-.410	1.519
Increase danger from radioactive materials, wastes	81	10.5	25	3.2	668	86.3	-1.346	1.250
Arouse threat of catastrophe	51	6.6	22	2.8	701	90.6	-1.435	1.130
Cause destruction of ecological environment	76	9.8	46	5.9	652	84.2	-1.386	1.267
Result in more nuclear plants	224	29.0	131	16.9	419	54.1	-.402	1.417
Increase threat of nuclear theft and sabotage	194	25.1	136	17.6	444	57.4	-.532	1.315

Scales range from +3 to -3
Good: +3 +2 +1
Neutral: 0
Bad: -1 -2 -3

was .517 (SD=1.374). Forty-seven percent of the subjects favorably evaluated that voting "yes" would increase public participation in nuclear decisions; however, 41.7 percent of the subjects did not; the mean score of this item was .044 (SD=1.434). Over half of the subjects (54.5%) favorably evaluated that voting "yes" would ensure low-cost electricity, and 32.6 percent of the subjects did not; the mean score of this item was .373 (SD=1.423). A majority of the subjects (86.2%) gave favorable evaluations for "new nuclear power plants help economic development," and the mean score of this item was 1.209 (SD=1.102). About 30 percent of the subjects gave favorable evaluations for "new nuclear power plants solve the problem of future energy shortages." On the other hand, over half of the subjects (58.3%) gave negative evaluations; the mean score of this item was -.410 (SD=1.519). A majority of the subjects (86.3%) gave negative evaluations for "new nuclear power plants increase the danger from radioactive materials and wastes"; the mean score of this item was -1.346 (SD=1.250). A majority of the subjects (90.6%) gave bad evaluations for "new nuclear power plants arouse the threat of catastrophe"; the mean score of this item was -1.435 (SD=1.130). Eighty-four percent of the subjects said that voting "yes" would cause the destruction of ecological environment; the mean score of this item was -1.386 (SD=1.267). Over half of the subjects (54.1%) evaluated that voting "yes" would result in

new nuclear power plants, and 29.0 percent of the subjects did not; the mean score of the item was -.402 (SD=1.417). Fifty-seven percent of the subjects evaluated that voting "yes" would increase the threat of nuclear theft and sabotage, and 25.1 percent of the subjects did not; the mean score of this item was -.532 (SD=1.315).

There also were significant percentages of neutral scores for "urge the government to develop new tests of nuclear safety systems" (10.7%), "increase public participation in nuclear decisions" (12.9%), "ensure low-cost electricity" (12.9%), "solve the problem of future energy shortages" (11.0%), "result in more new nuclear power plants" (16.9%), and "increase the threat of nuclear theft and sabotage" (17.6%).

Relationships Among Attitude, Beliefs of Outcomes, and Evaluations of Outcomes

Before analysis, rescales were made for "increase the danger from radioactive materials and wastes," "arouse the threat of catastrophe," "cause the destruction of ecological environment," "result in more new nuclear power plants," and "increase the threat of nuclear theft and sabotage" of both beliefs and evaluations of outcomes from -1 to +3, because the responses for these items were reversed. The correlation coefficient of attitude (Ab) was .5929 for beliefs of outcomes (Bi), .5669 for evaluations of outcomes (Ei), and .4037 for the product of beliefs of outcomes multiplied by evaluations of outcomes ($\Sigma Bi*Ei$). The

correlation coefficient of beliefs of outcomes (Bi) was .7534 for evaluations of outcomes (Ei) and .5613 for the product of beliefs of outcomes multiplied by evaluations of outcomes ($\Sigma Bi*Ei$). There also was positive correlation between evaluations of outcomes and the product of beliefs of outcomes multiplied by evaluations of outcomes ($r=.5825$). All of the correlations were at a significant level ($p<.01$) (see Table 10).

Subjective Norm, Normative Beliefs, Motivations to Comply with Important Referents, and the Relationships Among these Variables

From the theory of Fishbein's model (Ajzen & Fishbein, 1980), it was understood that a person's subjective norm is determined by his beliefs that specific salient referents think he should or should not perform a given behavior and by his motivations to comply with these referents. Therefore, this study examined subjective norm, normative beliefs, and motivations to comply with important referents, and identified the relationships among these variables.

Normative Beliefs of Important Referents

Results of normative beliefs of important referents for voting "yes" to build new nuclear power plants are summarized in Table 11. A majority of the subjects (over 85%) believed that enterprise groups, most governmental officials, and members of the power company thought they should vote in favor of new nuclear power plants.

Table 10. Pearson Product-Moment Correlation for the Relationships Among Attitude (Ab), Beliefs of Outcomes (Bi), Evaluations of Outcomes (Ei), and ΣBi*Ei

	Ab	Bi	Ei	ΣBi*Ei
Ab	1.0000			
Bi	.5929**	1.0000		
Ei	.5669**	.7534**	1.0000	
ΣBi*Ei	.4037**	.5613**	.5825**	1.0000

** P<.01

Table 11. Frequencies, Percentages, and Mean Scores on Normative Beliefs of Important Referents (NBj)

NBj	Likely		Neutral		Unlikely		Mean	SD
	n	%	n	%	n	%		
Most members of my family	390	50.4	151	19.5	233	30.1	.169	1.406
Enterprise groups	663	85.7	51	6.6	60	7.8	1.372	1.192
Environmental protection experts	122	15.8	46	5.9	606	78.3	-1.177	1.445
Most government officials	692	89.4	49	6.3	33	4.3	1.484	1.056
Members of the power company	684	88.4	55	7.1	35	4.5	1.578	1.126
Local residents	41	5.3	47	6.1	686	88.6	-1.970	1.270
Anti-nuclear power groups	55	7.1	45	5.8	674	87.1	-1.872	1.392
General population	460	59.4	122	15.8	192	24.8	.376	1.349

Scales range from +3 to -3
Likely: +3 +2 +1
Neutral: 0
Unlikely: -1 -2 -3

On the other hand, the majority of the subjects (over 78%) indicated that environmental protection experts, local residents of nuclear power plants, and antinuclear power groups thought they should not vote "yes."

Over half of the subjects believed that most family members and the general population thought they should vote "yes." However, there were significant percentages of neutrality for "most members of my family" (19.5%) and "the general population" (15.8%).

Motivations to Comply with Important Referents

The scale range of this variables is from +7 to +1. The high score means that students are more willing to do what important referents wanted them to do, and the low score means they are not. Results of motivations to comply with important referents are summarized in Table 12. A majority of the subjects were willing to do what most members of their families, environmental protection experts, and the general population thought they should do. On the other hand, over half of subjects (69.8%) were not willing to do what enterprise groups thought they should do, and only 19 percentage of the subjects agreed with enterprise groups. Almost equal counterparts of subjects were willing or not willing to do what most governmental officials, members of the power company, local residents near nuclear power plants, and anti-nuclear power groups thought they should do. There were 11 to 20 percent of neutrality for

Table 12. Frequencies, Percentages, and Mean Scores on Motivations to Comply with Important Referents (MCj)

MCj	Likely		Neutral		Unlikely		Mean	SD
	n	%	n	%	n	%		
Most members of my family	630	81.4	39	5.0	105	13.6	5.012	1.220
Enterprise groups	147	19.0	87	11.2	540	69.8	3.111	1.398
Environmental protection experts	670	86.6	26	3.4	78	10.0	5.211	1.203
Most government officials	268	34.6	140	18.1	366	47.3	3.636	1.365
Members of the power company	324	41.9	120	15.5	330	42.6	3.863	1.365
Local residents	339	43.8	131	16.9	304	39.3	4.013	1.351
Anti-nuclear power groups	245	31.7	166	21.4	363	46.9	3.740	1.366
General population	498	64.3	116	15.0	160	20.7	4.514	1.218

Scales range from +7 to +1
Likely: +7 +6 +5
Neutral: 4
Unlikely: +3 +2 +1

"enterprise groups," "most governmental officials," "members of the power company," "local residents near nuclear power plants," "anti-nuclear power groups," and "the general population."

Relationships Among Subjective Norm, Normative Beliefs, and Motivations to Comply with Important Referents

According to the results in Table 13, there were significant positive correlations between subjective norm (SN) and motivations to comply (MCj) (r=.1319**), between normative beliefs (NBj) and motivations to comply (MCj) (r=.1999**), and between motivations (MCj) and normative beliefs multiplied by motivations (ΣNBj*MCj) (r=.1736**). Furthermore, significantly positive correlations existed between subjective norm (SN) and normative beliefs (NBj) (r=.5963**), between subjective norm (SN) and normative beliefs multiplied by motivations (ΣNBj*MCj) (r=.6354**), and between normative beliefs (NBj) and ΣNBj*MCj (r=.8970**).

This result indicates that the higher the score of the product of normative beliefs weighted by motivations to comply with the important referents the subjects had, the more likely they perceived that most important referents thought they should vote "yes" and were willing to do.

Association Between External Factors and Behavioral Intention Toward New Nuclear Power Plants

The external factors included demographic variables--age, school, gender, socioeconomic status (SES), political

Table 13. List of Pearson Product-Moment Correlations Among Subjective Norm (SN), Normative Beliefs (NBj), Motivations to Comply with Important Referents (MCj), and ΣNBj*MCj

	SN	NBj	MCj	ΣNBj*MCj
SN	1.0000			
NBj	.5963**	1.0000		
MCj	.1319**	.1999**	1.0000	
ΣNBj*MCj	.6354**	.8970**	.1736**	1.0000

** P<.01

party affiliation, residence near/not near nuclear power plants, and residence with/without industrial pollution--and nuclear locus of control (NLOC) contained three subcomponents--internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC).

Due to the homogenesis of age of the studied students, age is not included as one of variables for correlation analysis. The results of correlations between intention and external factors are summarized in Table 14. Only political party affiliation, residence with/without industrial pollution, and INLOC and PNLOC variables showed significant correlation with behavioral intention. Therefore, further analyses were done to identify the relationships among these four external variables.

Political Party Affiliation

The result of beliefs of outcomes toward the proposal of new nuclear plants by party affiliation is summarized in Table 15. Except for "arousing the threat of catastrophe" and "resulting in more nuclear power plants," the other beliefs of outcomes showed significant differences among the three groups of party affiliation. For further analysis of Scheffe's comparison, the supporters of the current ruling party, Kuomintang (KMT), had significantly more favorable beliefs than did the supporters of the opposition party,

Table 14. List of Pearson Product-Moment Correlations Among External Factors and Behavioral Intention (BI)

	Univ.	Sex	SES	PA	Res.1	Res.2	INLOC	PNLOC	CNLOC	BI
Univ.	1.000									
Sex	.102*	1.000								
SES	.038	-.137*	1.000							
PA	.050	.128*	.031	1.000						
Res.1	.097*	.002	-.034	.043	1.000					
Res.2	.073	.038	.074	.007	.047	1.000				
INLOC	.040	-.007	-.017	.006	-.021	.079	1.000			
PNLOC	.058	.018	-.016	.109*	-.038	.110*	-.069	1.000		
CNLOC	.066	.013	-.045	.080	.054	.068	-.145*	.168*	1.000	
BI	.072	-.059	.013	.246*	-.015	.103*	.121*	-.183*	.060	1.000

SES: Socioeconomic status produced from parents' educational status multiplied by parents' occupational status with weighting and categorization
PA: Political party affiliation
Res.1: County of residence near/not near nuclear power plants
Res.2: Place of residence with/without industrial pollution
INLOC: Internal nuclear locus of control
PNLOC: Powerful others nuclear locus of control
CNLOC: Chance nuclear locus of control
* P<.05

Table 15. One-Way ANOVA of Beliefs of Outcomes (Bi) by Political Party Affiliation (PA)

Bi	PA	n	Mean	SD	F	Scheffe's
Urge government to develop new safe systems of tests	(1)KMT	173	1.017	1.128	17.889**	(1)>(2)
	(2)DPP	40	-.050	1.552		(1)>(3)
	(3)OTH	561	.517	1.183		(2)<(3)
Increase public nuclear decisions	(1)KMT	173	.156	1.222	7.761**	(1)>(2)
	(2)DPP	40	-.700	1.363		(2)<(3)
	(3)OTH	561	-.105	1.289		
Ensure low-cost electricity	(1)KMT	173	.676	1.381	5.432**	(1)>(2)
	(2)DPP	40	.025	1.593		(1)>(3)
	(3)OTH	561	.333	1.391		
Help economic development	(1)KMT	173	1.763	.932	17.982**	(1)>(2)
	(2)DPP	40	1.025	.999		(1)>(3)
	(3)OTH	561	1.283	1.014		
Solve future energy shortages	(1)KMT	173	.434	1.456	10.837**	(1)>(2)
	(2)DPP	40	-.550	1.584		(1)>(3)
	(3)OTH	561	-.052	1.434		
Increase danger from radioactive materials, wastes	(1)KMT	173	1.272	1.147	7.025**	(1)<(2)
	(2)DPP	40	1.875	.939		(1)<(3)
	(3)OTH	561	1.585	1.139		
Arouse threat of catastrophe	(1)KMT	173	1.387	1.129	2.442	
	(2)DPP	40	1.825	.931		
	(3)OTH	561	1.492	1.151		
Cause destruction of the ecological environment	(1)KMT	173	1.410	1.094	4.150*	(1)<(2)
	(2)DPP	40	2.000	.847		(2)>(3)
	(3)OTH	561	1.513	1.207		
Result in more nuclear plants	(1)KMT	173	.647	1.200	1.118	
	(2)DPP	40	.975	1.561		
	(3)OTH	561	.749	1.298		
Increase threat of nuclear theft and sabotage	(1)KMT	173	.520	1.159	3.972*	(1)<(2)
	(2)DPP	40	1.150	1.578		
	(3)OTH	561	.606	1.294		

KMT: Kuomintang
DPP: Democratic Progressive Party
OTH: Other parties and no party affiliation
* P<.05, ** P<.01

Democratic Progressive Party (DPP), on all beliefs of outcomes.

Supporters of KMT also showed more favorable beliefs than supporters of other parties and those with no party affiliation on "urging the government to develop new tests of nuclear safety systems," "ensuring low-cost electricity," "helping economic development," "solving the problem of future energy shortages," and "increasing the danger from radioactive materials and wastes."

At the same time, the supporters of other parties and those with no party affiliation had more favorable beliefs than supporters of DPP on "urging the government to develop new tests of nuclear safety systems," "increasing public participation in nuclear decisions," "causing the destruction of the ecological environment," and "increasing the threat of nuclear theft and sabotage."

In regard to evaluations of outcomes (Table 16), it was noted that except for "arousing the threat of catastrophe" and "resulting in more nuclear power plants," there were more significantly favorable evaluations by the supporters of KMT than those of DPP. At the same time, the supporters of KMT also showed more favorable evaluations than those of other parties and those with no party affiliation on "urge the government to develop new tests of nuclear safety systems," "help economic development," and "solve the problem of future energy shortages."

Table 16. One-Way ANOVA of Evaluations of Outcomes (Ei) by Political Party Affiliation (PA)

Ei	PA	n	Mean	SD	F	Scheffe's
Urge government to develop new safe systems of tests	(1)KMT	173	.861	1.202	8.932**	(1)>(2) (1)>(3)
	(2)DPP	40	.025	1.819		
	(3)OTH	561	.446	1.368		
Increase public participation in nuclear decisions	(1)KMT	173	.214	1.375	4.701**	(1)>(2) (2)<(3)
	(2)DPP	40	-.550	1.679		
	(3)OTH	561	.034	1.425		
Ensure low-cost electricity	(1)KMT	173	.561	1.416	4.053**	(1)>(2)
	(2)DPP	40	-.125	1.727		
	(3)OTH	561	.351	1.394		
Help economic development	(1)KMT	173	1.584	.909	16.345**	(1)>(2) (1)>(3)
	(2)DPP	40	.700	1.400		
	(3)OTH	561	1.130	1.103		
Solve future energy shortages	(1)KMT	173	.006	1.626	11.958**	(1)>(2) (1)>(3) (2)<(3)
	(2)DPP	40	-1.125	1.636		
	(3)OTH	561	-.487	1.446		
Increase danger from radioactive materials, wastes	(1)KMT	173	-1.145	1.315	4.585**	(1)>(2)
	(2)DPP	40	-1.750	1.171		
	(3)OTH	561	-1.380	1.226		
Arouse threat of catastrophe	(1)KMT	173	-1.341	1.091	1.369	
	(2)DPP	40	-1.650	1.210		
	(3)OTH	561	-1.449	1.135		
Cause destruction of the ecological environment	(1)KMT	173	-1.278	1.117	3.336*	(1)>(2)
	(2)DPP	40	-1.850	1.210		
	(3)OTH	561	-1.387	1.309		
Result in more nuclear plants	(1)KMT	173	-.289	1.275	1.461	
	(2)DPP	40	-.700	1.667		
	(3)OTH	561	-.415	1.438		
Increase threat of nuclear theft and sabotage	(1)KMT	173	-.428	1.249	3.377*	(1)>(2)
	(2)DPP	40	-1.025	1.577		
	(3)OTH	561	-.529	1.309		

KMT: Kuomintang
DPP: Democratic Progressive Party
OTH: Other parties and no party affiliation
* P<.05, ** P<.01

However, the supporters of KMT were still concerned about "increasing the danger from radioactive materials and wastes," "arousing the threat of catastrophe," and "causing destruction of the ecological environment."

On the other hand, the supporters of other parties and those with no party affiliation expressed more favorable evaluations than supporters of DPP on "increase public participation in nuclear decisions" and "solve the problem of future energy shortages."

About normative beliefs, it can be seen from Table 17 that there are three items of normative beliefs that are significantly different among the three groups of political party affiliation. Results indicated that supporters of KMT more than those of DPP perceived most of their families, environmental protection experts, and the general population wanted them to vote "yes" for the proposal of new nuclear power plants.

At the same time, the supporters of KMT more than those of other parties and those with no party affiliation perceived that most family members and the general population wanted them to vote "yes." Supporters of all three groups of party affiliation also perceived that enterprise groups, most governmental officials, and members of the power company wanted them to vote "yes," and perceived that local residents near nuclear power plants and anti-nuclear power groups did not want them to vote "yes."

Table 17. One-Way ANOVA of Normative Beliefs (NBj) of Important Referents by Political Party Affiliation (PA)

NBj	PA	n	Mean	SD	F	Scheffe's
Most members of my family	(1)KMT	173	.705	1.215	21.344**	(1)>(2)
	(2)DPP	40	-.600	1.646		(1)>(3)
	(3)OTH	561	.059	1.395		(2)<(3)
Enterprise groups	(1)KMT	173	1.497	1.092	1.282	
	(2)DPP	40	1.275	1.432		
	(3)OTH	561	1.341	1.203		
Environmental protection experts	(1)KMT	173	-.931	1.461	4.550*	(1)>(2)
	(2)DPP	40	-1.600	1.392		
	(3)OTH	561	-1.223	1.435		
Most government officials	(1)KMT	173	1.567	1.007	.908	
	(2)DPP	40	1.350	1.292		
	(3)OTH	561	1.469	1.052		
Members of the power company	(1)KMT	173	1.659	1.123	.617	
	(2)DPP	40	1.600	1.533		
	(3)OTH	561	1.551	1.095		
Local residents	(1)KMT	173	-1.786	1.314	2.898	
	(2)DPP	40	-2.225	1.230		
	(3)OTH	561	-2.009	1.254		
Anti-nuclear power groups	(1)KMT	173	-1.948	1.268	.772	
	(2)DPP	40	-2.050	1.338		
	(3)OTH	561	-1.836	1.432		
General population	(1)KMT	173	.653	1.274	5.805**	(1)>(2)
	(2)DPP	40	.000	1.649		(1)>(3)
	(3)OTH	561	.317	1.337		

KMT: Kuomintang
DPP: Democratic Progressive Party
OTH: Other parties and no party affiliation
* p<.05, ** p<.01

For motivations to comply with important referents, it is noted from Table 18 that there were six items of motivations to be significant among the three groups of political party affiliation. For further analysis of Scheffe's comparison, the supporters of KMT were more willing to do what the following social referents think they should do than were those of DPP: most family members, enterprise groups, most governmental officials, and members of the power company. At the same time, the supporters of KMT more than those of other parties and those with no party affiliation were willing to do what most family members, most governmental officials, members of the power company, and the general population think they should do.

However, the supporters of DPP were more willing to do what anti-nuclear power groups think they should do than were those of KMT and of other parties and those with no party affiliation.

Political Party Affiliation and Its Impact on Attitude, Subjective Norm, and Behavioral Intention

Results of attitude, subjective norm, and behavioral intention toward the proposal of new nuclear power plants by political party affiliation is summarized in Table 19. There were significant differences in attitude, subjective norm, and behavioral intention among subjects of the three groups of political party affiliation. In further analysis by Scheffe's comparison, the results indicated that supporters of KMT and other parties and those with no party

Table 18. One-Way ANOVA of Motivations to Comply with Important Referents (MCj) by Political Party Affiliation (PA)

NBj	PA	n	Mean	SD	F	Scheffe's
Most members of my family	(1)KMT	173	5.364	.889	9.686**	(1)>(2)
	(2)DPP	40	4.800	1.556		(1)>(3)
	(3)OTH	561	4.918	1.262		
Enterprise groups	(1)KMT	173	3.312	1.349	3.698*	(1)>(2)
	(2)DPP	40	2.700	1.400		
	(3)OTH	561	3.078	1.406		
Environmental protection experts	(1)KMT	173	5.260	1.103	.326	
	(2)DPP	40	5.100	1.482		
	(3)OTH	561	5.203	1.212		
Most government officials	(1)KMT	173	4.197	1.265	23.561**	(1)>(2)
	(2)DPP	40	2.925	1.482		(1)>(3)
	(3)OTH	561	3.513	1.334		(2)<(3)
Members of the power company	(1)KMT	173	4.197	1.199	9.650**	(1)>(2)
	(2)DPP	40	3.275	1.694		(1)>(3)
	(3)OTH	561	3.802	1.366		
Local residents	(1)KMT	173	3.925	1.351	1.807	
	(2)DPP	40	4.375	1.531		
	(3)OTH	561	4.014	1.336		
Anti-nuclear power groups	(1)KMT	173	3.468	1.265	10.393**	(1)<(2)
	(2)DPP	40	4.525	1.935		(1)<(3)
	(3)OTH	561	3.768	1.326		(2)>(3)
General population	(1)KMT	173	4.734	1.104	3.739*	(1)>(3)
	(2)DPP	40	4.375	1.690		
	(3)OTH	561	4.456	1.207		

KMT: Kuomintang
DPP: Democratic Progressive Party
OTH: Other parties and no party affiliation
* p<.05, ** p<.01

Table 19. One-Way ANOVA of Attitude (Ab), Subjective Norm (SN), and Behavioral Intention (BI) by Political Party Affiliation (PA)

NBj	PA	n	Mean	SD	F	Scheffe's
Ab	(1)KMT	173	.963	1.199	25.204**	(1)>(2)
	(2)DPP	40	-.500	1.872		(1)>(3)
	(3)OTHER	561	.232	1.446		(2)<(3)
SN	(1)KMT	173	.584	1.299	21.485*	(1)>(2)
	(2)DPP	40	-.763	1.758		(1)>(3)
	(3)OTHER	561	-.075	1.403		(2)<(3)
BI	(1)KMT	173	1.173	1.472	24.917**	(1)>(2)
	(2)DPP	40	-.575	2.123		(1)>(3)
	(3)OTHER	561	.250	1.810		(2)<(3)

KMT: Kuomintang
DPP: Democratic Progressive Party
OTHER: Other parties and no party affiliation
* p<.05, ** p<.01

affiliation showed significantly greater favorable attitude, subjective norm, and behavioral intention for voting "yes" than did supporters of DPP.

In addition, supporters of KMT also showed greater favorable attitude, subjective norm, and behavioral intention than those of other parties and those with no party affiliation.

Residence

From results shown in Table 20, there are no significant differences in beliefs of outcomes among subjects of the three groups for the place of residence variable. No matter where the subjects lived, with or without industrial pollution, or not knowing about the pollution, they gave significantly more unfavorable responses on "increasing public participation in nuclear decisions," "increasing the danger from radioactive materials and wastes," "arousing the threat of catastrophe," and "causing the destruction of ecological environment."

There was only one item of evaluation that was significant among subjects in the three groups for the place of residence as presented in Table 21. For further analysis of Scheffe's comparison, subjects living in places without industrial pollution showed more favorable evaluations for "increasing public participation in nuclear decisions" than did those living in areas with pollution. On the other hand, there were favorable evaluations for "increasing the

Table 20. One-Way ANOVA of Beliefs of Outcomes (Bi) by Residence

Bi	Resid.	n	Mean	SD	F
Urge government to develop new safe systems of tests	(1)W.1	120	.392	1.368	3.038
	(2)W.2	590	.659	1.176	
	(3)UNK	64	.438	1.271	
Increase public participation in nuclear decisions	(1)W.1	120	-.208	1.517	2.739
	(2)W.2	590	-.020	1.233	
	(3)UNK	64	-.359	1.301	
Ensure low-cost electricity	(1)W.1	120	.492	1.593	.784
	(2)W.2	590	.393	1.361	
	(3)UNK	64	.219	1.474	
Help economic development	(1)W.1	120	1.558	1.003	2.291
	(2)W.2	590	1.341	.991	
	(3)UNK	64	1.375	1.241	
Solve future energy shortages	(1)W.1	120	.150	1.465	.520
	(2)W.2	590	.015	1.463	
	(3)UNK	64	-.047	1.495	
Increase danger from radioactive materials, wastes	(1)W.1	120	1.683	1.10	1.708
	(2)W.2	590	1.488	1.159	
	(3)UNK	64	1.625	1.016	
Arouse threat of catastrophe	(1)W.1	120	1.567	1.200	1.698
	(2)W.2	590	1.495	1.130	
	(3)UNK	64	1.250	1.084	
Cause destruction of the ecological environment	(1)W.1	120	1.717	1.146	2.101
	(2)W.2	590	1.480	1.150	
	(3)UNK	64	1.469	1.380	
Result in more nuclear plants	(1)W.1	120	.892	1.516	1.973
	(2)W.2	590	.686	1.260	
	(3)UNK	64	.922	1.088	
Increase threat of nuclear theft and sabotage	(1)W.1	120	.567	1.454	.351
	(2)W.2	590	.636	1.242	
	(3)UNK	64	.516	1.369	

W.1: places with industrial pollution
W.2: places without industrial pollution
UNK: do not know if the place is with/without industrial pollution

Table 21. One-Way ANOVA of Evaluations of Outcomes (Ei) by Residence

Ei	Resid.	n	Mean	SD	F	Scheffe's
Urge government to develop new safe systems of tests	(1)W.1	120	.317	1.619	1.518	
	(2)W.2	590	.556	1.329		
	(3)UNK	64	.531	1.272		
Increase public participation in nuclear decisions	(1)W.1	120	-.308	1.644	4.834**	(1)<(2)
	(2)W.2	590	.127	1.377		
	(3)UNK	64	-.063	1.446		
Ensure low-cost electricity	(1)W.1	120	.317	1.593	.684	
	(2)W.2	590	.403	1.392		
	(3)UNK	64	.203	1.371		
Help economic development	(1)W.1	120	1.292	1.198	.487	
	(2)W.2	590	1.188	1.060		
	(3)UNK	64	1.250	1.285		
Solve future energy shortages	(1)W.1	120	-.517	1.461	1.094	
	(2)W.2	590	-.366	1.531		
	(3)UNK	64	-.609	1.508		
Increase danger from radioactive materials, wastes	(1)W.1	120	-1.433	1.327	.439	
	(2)W.2	590	-1.337	1.220		
	(3)UNK	64	-1.266	1.383		
Arouse the threat of catastrophe	(1)W.1	120	-1.433	1.295	.536	
	(2)W.2	590	-1.451	1.106		
	(3)UNK	64	-1.297	1.019		
Cause destruction of the ecological environment	(1)W.1	120	-1.558	1.333	1.524	
	(2)W.2	590	-1.344	1.233		
	(3)UNK	64	-1.453	1.436		
Result in more nuclear plants	(1)W.1	120	-.700	1.663	3.390	
	(2)W.2	590	-.359	1.362		
	(3)UNK	64	-.234	1.366		
Increase threat of nuclear theft and sabotage	(1)W.1	120	-.542	1.340	.023	
	(2)W.2	590	-.534	1.311		
	(3)UNK	64	-.500	1.321		

W.1: places with industrial pollution
W.2: places without industrial pollution
UNK: do not know if the place is with/without industrial pollution
** P<.01

danger from radioactive materials and wastes," "arousing the threat of catastrophe," and "causing the destruction of the ecological environment" for all three places of residence groups.

In regard to normative beliefs, there was no significant difference among subjects of the three groups for the place of residence variable (see Table 22). However, all subjects living with/without industrial pollution and those not sure about the pollution perceived environmental protection experts, local residents near nuclear power plants, and anti-nuclear power groups as not wanting them to vote in favor of the proposal of new nuclear power plants. On the other hand, all subject groups perceived enterprise groups, most governmental officials, and members of the power company as wanting them to vote "yes" at a significant level.

About motivations, there was no significant difference among subjects of the three groups for the place of residence variable, as shown in Table 23. All of the subjects whose residences were affected or not affected by industrial pollution in this study were willing to do what most family members and environmental protection experts wanted them to do.

Residence and Its Impact on Attitude, Subjective Norm, and Behavioral Intention Toward New Nuclear Power Plants

The results of this analysis indicated that residence affected only the behavioral intention to vote for new

Table 22. One-Way ANOVA of Normative Beliefs (NBj) of Important Referents by Residence

NBj	Resid.	n	Mean	SD	F
Most members of my family	(1)W.1	120	-.033	1.577	2.133
	(2)W.2	590	.227	1.368	
	(3)UNK	64	.016	1.397	
Enterprise groups	(1)W.1	120	1.500	1.353	.884
	(2)W.2	590	1.354	1.160	
	(3)UNK	64	1.297	1.164	
Environmental protection experts	(1)W.1	120	-1.400	1.536	1.696
	(2)W.2	590	-1.137	1.431	
	(3)UNK	64	-1.125	1.386	
Most government officials	(1)W.1	120	1.675	1.175	2.461
	(2)W.2	590	1.442	1.004	
	(3)UNK	64	1.516	1.247	
Members of the power company	(1)W.1	120	1.625	1.297	.205
	(2)W.2	590	1.575	1.087	
	(3)UNK	64	1.516	1.155	
Local residents	(1)W.1	120	-2.075	1.323	.610
	(2)W.2	590	-1.960	1.256	
	(3)UNK	64	-1.875	1.303	
Anti-nuclear power groups	(1)W.1	120	-2.017	1.341	.769
	(2)W.2	590	-1.844	1.397	
	(3)UNK	64	-1.859	1.446	
General population	(1)W.1	120	.133	1.561	2.344
	(2)W.2	590	.425	1.293	
	(3)UNK	64	.375	1.409	

W.1: places with industrial pollution
W.2: places without industrial pollution
UNK: do not know if the place is with/without industrial pollution

Table 23. One-Way ANOVA of Motivations to Comply with Important Referents (MCj) by Residence

NBj	Resid.	n	Mean	SD	F
Most members of my family	(1)W.1	120	4.825	1.268	2.132
	(2)W.2	590	5.061	1.215	
	(3)UNK	64	4.906	1.151	
Enterprise groups	(1)W.1	120	2.833	1.463	2.819
	(2)W.2	590	3.161	1.394	
	(3)UNK	64	3.172	1.267	
Environmental protection experts	(1)W.1	120	5.242	1.366	1.240
	(2)W.2	590	5.229	1.155	
	(3)UNK	64	4.984	1.303	
Most government officials	(1)W.1	120	3.442	1.565	1.898
	(2)W.2	590	3.688	1.327	
	(3)UNK	64	3.516	1.297	
Members of the power company	(1)W.1	120	3.700	1.447	1.035
	(2)W.2	590	3.897	1.352	
	(3)UNK	64	3.859	1.320	
Local residents	(1)W.1	120	4.117	1.456	.692
	(2)W.2	590	4.007	1.334	
	(3)UNK	64	3.875	1.315	
Anti-nuclear power groups	(1)W.1	120	3.783	1.462	.076
	(2)W.2	590	3.731	1.353	
	(3)UNK	64	3.750	1.321	
General population	(1)W.1	120	4.442	1.249	1.525
	(2)W.2	590	4.553	1.214	
	(3)UNK	64	4.297	1.191	

W.1: places with industrial pollution
W.2: places without industrial pollution
UNK: do not know if the place is with/without industrial pollution

nuclear power plants but did not affect attitude and subjective norm (see Table 24). Further analysis indicated that subjects living in places without industrial pollution showed more favorable behavioral intention than did those living in places with industrial pollution.

Internal Nuclear Locus of Control and Its Relationships with Beliefs and Evaluations of Outcomes, Normative Beliefs, and Motivations

Internal nuclear locus of control (INLOC) was divided into a high group and a low group according to mean score (mean=18). There were five items of beliefs with significant differences for these two groups, as shown in Table 25. Using Hotelling's T^2 analysis, the group of students scoring high on INLOC more than the group scoring low on INLOC expressed significantly more favorable beliefs on "urging the government to develop new tests of nuclear safety systems," "increasing public participation in nuclear decisions," "ensuring low-lost electricity," "helping economic development," and "solving the problem of future energy shortages."

On the other hand, there were no significant differences in the rest of the beliefs for these two groups. However, both groups showed significantly more unfavorable beliefs on "increasing the danger from radioactive materials and wastes," "arousing the threat of catastrophe," and "causing the destruction of the ecological environment."

Table 24. One-Way ANOVA of Attitude (Ab), Subjective Norm (SN), and Behavioral Intention (BI) by Residence

Variables	Resid.	n	Mean	SD	F	Scheffe's
Attitude	(1)W.1	120	.106	1.539	2.790	
	(2)W.2	590	.426	1.427		
	(3)UNK	64	.203	1.616		
Subjective Norm	(1)W.1	120	-.229	1.491	2.546	
	(2)W.2	590	.094	1.421		
	(3)UNK	64	.008	1.454		
Behavioral Intention	(1)W.1	120	-.017	2.004	4.147*	(1)<(2)
	(2)W.2	590	.503	1.743		
	(3)UNK	64	.391	1.965		

W.1: places with industrial pollution
W.2: places without industrial pollution
UNK: do not know if the place is with/without industrial pollution
* P<.05

Table 25. Hotelling's T^2 of Beliefs of Outcomes (Bi) by Internal Nuclear Locus of Control (INLOC)

Bi	INLOC	n	Mean	SD	F
Urge government to develop new safe systems of tests	H-INLOC	420	.802	1.113	26.29**
	L-INLOC	354	.359	1.294	
Increase public participation in nuclear decisions	H-INLOC	420	.183	1.198	39.45**
	L-INLOC	354	-.387	1.327	
Ensure low-cost electricity	H-INLOC	420	.581	1.343	16.50**
	L-INLOC	354	.172	1.452	
Help economic development	H-INLOC	420	1.486	.933	10.57**
	L-INLOC	354	1.249	1.096	
Solve future energy shortages	H-INLOC	420	.179	1.404	9.42**
	L-INLOC	354	-.144	1.518	
Increase danger from radioactive materials, wastes	H-INLOC	420	1.467	1.123	2.81
	L-INLOC	354	1.605	1.157	
Arouse threat of catastrophe	H-INLOC	420	1.476	1.078	.07
	L-INLOC	354	1.497	1.207	
Cause destruction of the ecological environment	H-INLOC	420	1.500	1.104	.16
	L-INLOC	354	1.534	1.248	
Result in more nuclear plants	H-INLOC	420	.755	1.194	.16
	L-INLOC	354	.718	1.400	
Increase threat of nuclear theft and sabotage	H-INLOC	420	.631	1.283	.14
	L-INLOC	354	.596	1.292	

H-INLOC: high score of internal nuclear locus of control
L-INLOC: low score of internal nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.93539; Exact F=5.27020; df=10/763; P<.01
** P<.01

In regard to evaluations of outcomes, results for both groups for internal nuclear locus of control (INLOC) from Table 26 are the same as those for beliefs from Table 25. The group of students scoring high on INLOC more than the group scoring low on INLOC expressed significantly more favorable evaluations on "urge the government to develop new tests of nuclear safety systems," "increase public participation in nuclear decisions," "ensure low-cost electricity," "help economic development," and "solve the problem of future energy shortages."

There were no significant differences in normative beliefs between these two groups (see Table 27). Both groups of INLOC perceived that enterprise groups, most governmental officials, and members of the power company want them to vote "yes" for the proposal of new nuclear power plants, but that environmental protection experts, local residents, and anti-nuclear power groups want them to vote "no."

Results of motivations for these two groups are summarized in Table 28. It was seen that all motivations except "anti-nuclear power groups" were significant between these two groups of INLOC. Except for anti-nuclear power groups, the group of students scoring high on INLOC more than the group scoring low on INLOC were willing to do what most important referents think they should do.

Table 26. Hotelling's T^2 of Evaluations of Outcomes (Ei) by Internal Nuclear Locus of Control (INLOC)

Ei	INLOC	n	Mean	SD	F
Urge government to develop new safe systems of tests	H-INLOC	420	.743	1.215	25.65**
	L-INLOC	354	.249	1.500	
Increase public participation in nuclear decisions	H-INLOC	420	.367	1.333	46.35**
	L-INLOC	354	-.328	1.463	
Ensure low-cost electricity	H-INLOC	420	.579	1.368	19.55**
	L-INLOC	354	.130	1.450	
Help economic development	H-INLOC	420	1.357	.973	16.88**
	L-INLOC	354	1.034	1.216	
Solve future energy shortages	H-INLOC	420	-.236	1.486	12.21**
	L-INLOC	354	-.616	1.533	
Increase danger from radioactive materials, wastes	H-INLOC	420	-1.314	1.211	.60
	L-INLOC	354	-1.384	1.295	
Arouse threat of catastrophe	H-INLOC	420	-1.402	1.100	.78
	L-INLOC	354	-1.475	1.164	
Cause destruction of the ecological environment	H-INLOC	420	-1.357	1.201	.49
	L-INLOC	354	-1.421	1.343	
Result in more nuclear plants	H-INLOC	420	-.419	1.347	.14
	L-INLOC	354	-.381	1.497	
Increase threat of nuclear theft and sabotage	H-INLOC	420	-.486	1.295	1.15
	L-INLOC	354	-.588	1.338	

H-INLOC: high score of internal nuclear locus of control
L-INLOC: low score of internal nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.93355; Exact F=5.43145; df=10/763; P<.01
** P<.01

Table 27. Hotelling's T^2 of Normative Beliefs (NBj) of Important Referents by Internal Nuclear Locus of Control (INLOC)

NBj	INLOC	n	Mean	SD
Most members of my family	H-INLOC	420	.255	1.359
	L-INLOC	354	.068	1.456
Enterprise groups	H-INLOC	420	1.383	1.170
	L-INLOC	354	1.359	1.220
Environmental protection experts	H-INLOC	420	-1.110	1.388
	L-INLOC	354	-1.257	1.509
Most government officials	H-INLOC	420	1.457	1.037
	L-INLOC	354	1.517	1.078
Members of the power company	H-INLOC	420	1.600	1.071
	L-INLOC	354	1.551	1.190
Local residents	H-INLOC	420	-1.857	1.283
	L-INLOC	354	-2.105	1.243
Anti-nuclear power groups	H-INLOC	420	-1.790	1.410
	L-INLOC	354	-1.969	1.366
General population	H-INLOC	420	.414	1.291
	L-INLOC	354	.331	1.417

H-INLOC: high score of internal nuclear locus of control
L-INLOC: low score of internal nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.98589; Exact F=1.36836; df=8/765; P>.05

Table 28. Hotelling's T^2 of Motivations to Comply with Important Referents (MCj) by Internal Nuclear Locus of Control (INLOC)

MCj	INLOC	n	Mean	SD	F
Most members of my family	H-INLOC	420	5.110	1.087	5.94*
	L-INLOC	354	4.895	1.354	
Enterprise groups	H-INLOC	420	3.269	1.396	11.89**
	L-INLOC	354	2.924	1.379	
Environmental protection experts	H-INLOC	420	5.338	1.129	10.44**
	L-INLOC	354	5.059	1.270	
Most government officials	H-INLOC	420	3.767	1.281	8.54**
	L-INLOC	354	3.480	1.446	
Members of the power company	H-INLOC	420	4.007	1.290	10.36**
	L-INLOC	354	3.692	1.432	
Local residents	H-INLOC	420	4.143	1.316	8.57**
	L-INLOC	354	3.859	1.379	
Anti-nuclear power groups	H-INLOC	420	3.767	1.350	.34
	L-INLOC	354	3.709	1.387	
General population	H-INLOC	420	4.605	1.165	5.10*
	L-INLOC	354	4.407	1.272	

H-INLOC: high score of internal nuclear locus of control
L-INLOC: low score of internal nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.96192; Exact F=3.78590; df=8/765; P<.01
* P<.05, **P<.01

Internal Nuclear Locus of Control and Its Impact on Attitude, Subjective Norms, and Behavioral Intention

It was seen that the group of students scoring high on internal nuclear locus of control (INLOC) more than the group scoring low on INLOC expressed significantly more favorable attitude and behavioral intention, and perceived that most important referents want them to vote in favor of the proposal of new nuclear power plants (Table 29).

Powerful Others Nuclear Locus of Control and Its Relationships with Beliefs and Evaluations of Outcomes, Normative Beliefs, and Motivations

Powerful others nuclear locus of control (PNLOC) was divided into high and low groups according to mean score (mean=19). There were nine items of beliefs of outcomes that were significantly different between the two groups, and only one item was not significantly different from results in Table 30. The group of students scoring low on PNLOC more than the group scoring high on PNLOC expressed significantly more favorable beliefs on "urge the government to develop new tests of nuclear safety systems," "increase public participation in nuclear decisions," "ensure low-cost electricity," "help economic development," "increase the danger from radioactive materials and wastes," "arouse the threat of catastrophe," "cause the destruction of the ecological environment," "result in more new nuclear power plants," and "increase the threat of nuclear theft and sabotage." However, these two groups on PNLOC showed unfavorable beliefs on "increasing the danger from

Table 29. One-Way ANOVA of Attitude (Ab), Subjective Norm (SN), and Behavioral Intention (BI) by Internal Nuclear Locus of Control (INLOC)

Variables	INLOC	n	Mean	SD	F
Attitude	H-INLOC	420	.5706	1.4382	19.86**
	L-INLOC	354	.1055	1.4568	
Subjective Norm	H-INLOC	420	.2155	1.3945	14.43**
	L-INLOC	354	-.1751	1.4607	
Behavioral Intention	H-INLOC	420	.6167	1.7142	11.71**
	L-INLOC	354	.1723	1.8956	

H-INLOC: high score of internal nuclear locus of control
L-INLOC: low score of internal nuclear locus of control
** P<.01

Table 30. Hotelling's T^2 of Beliefs of Outcomes (Bi) by Powerful Others Nuclear Locus of Control (PNLOC)

Bi	PNLOC	n	Mean	SD	F
Urge government to develop new safe systems of tests	H-PNLOC	362	.442	1.222	11.51**
	L-PNLOC	412	.738	1.200	
Increase public participation in nuclear decisions	H-PNLOC	362	-.271	1.282	15.55**
	L-PNLOC	412	.092	1.273	
Ensure low-cost electricity	H-PNLOC	362	.279	1.448	4.56*
	L-PNLOC	412	.495	1.366	
Help economic development	H-PNLOC	362	1.262	1.037	8.75**
	L-PNLOC	412	1.478	.990	
Solve future energy shortages	H-PNLOC	362	-.036	1.442	1.42
	L-PNLOC	412	.090	1.484	
Increase danger from radioactive materials, wastes	H-PNLOC	362	1.677	1.135	11.47**
	L-PNLOC	412	1.400	1.130	
Arouse the threat of catastrophe	H-PNLOC	362	1.622	1.192	9.79**
	L-PNLOC	412	1.367	1.076	
Cause destruction of the ecological environment	H-PNLOC	362	1.702	1.106	17.53**
	L-PNLOC	412	1.352	1.204	
Result in more nuclear plants	H-PNLOC	362	.892	1.359	9.85**
	L-PNLOC	412	.602	1.215	
Increase threat of nuclear theft and sabotage	H-PNLOC	362	.754	1.345	8.03**
	L-PNLOC	412	.493	1.221	

H-PNLOC: high score of powerful other nuclear locus of control
L-PNLOC: low score of powerful other nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.94541; Exact F=4.40614; df=10/763; P<.01
* P<.05, ** P<.01

radioactive materials and wastes," "arousing the threat of catastrophe," and "causing the destruction of the ecological environment."

Results of evaluations of outcomes for the two groups are summarized in Table 31. The group of students scoring low on PNLOC more than the group scoring high on PNLOC showed significantly more favorable evaluations on "urge the government to develop new tests of nuclear safety systems," "increase public participation in nuclear decisions," "help economic development," "arouse the threat of catastrophe," "cause the destruction of the ecological environment," "result in more new nuclear power plants," and "increase the threat of nuclear theft and sabotage." However, both groups also showed unfavorable evaluations on "arouse the threat of catastrophe" and "cause the destruction of ecological environment."

There were only two items of normative beliefs that were significantly different between the two groups as presented in Table 32. The group of students scoring low on PNLOC more than the group scoring high on PNLOC perceived that most members of their families and environmental protection experts wanted them to vote in favor of the proposal of new nuclear power plants. However, these two groups of PNLOC perceived environmental protection experts as not wanting them to vote "yes."

Table 31. Hotelling's T^2 of Evaluations of Outcomes (Ei) by Powerful Others Nuclear Locus of Control (PNLOC)

Ei	PNLOC	n	Mean	SD	F
Urge government to develop new safe systems of tests	H-PNLOC	362	.337	1.471	11.81**
	L-PNLOC	412	.675	1.264	
Increase public participation in nuclear decisions	H-PNLOC	362	-.119	1.479	8.84**
	L-PNLOC	412	.187	1.380	
Ensure low-cost electricity	H-PNLOC	362	.290	1.411	2.34
	L-PNLOC	412	.447	1.431	
Help economic development	H-PNLOC	362	1.091	1.153	7.89**
	L-PNLOC	412	1.313	1.045	
Solve future energy shortages	H-PNLOC	362	-.508	1.506	2.88
	L-PNLOC	412	-.323	1.527	
Increase danger from radioactive materials, wastes	H-PNLOC	362	-1.378	1.329	.45
	L-PNLOC	412	-1.318	1.177	
Arouse threat of catastrophe	H-PNLOC	362	-1.552	1.195	7.37**
	L-PNLOC	412	-1.333	1.060	
Cause destruction of the ecological environment	H-PNLOC	362	-1.544	1.211	10.69**
	L-PNLOC	412	-1.248	1.300	
Result in more nuclear plants	H-PNLOC	362	-.602	1.471	13.83**
	L-PNLOC	412	-.226	1.345	
Increase threat of nuclear theft and sabotage	H-PNLOC	362	-.644	1.335	4.90*
	L-PNLOC	412	-.434	1.291	

H-PNLOC: high score of powerful other nuclear locus of control
L-PNLOC: low score of powerful other nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.95314; Exact F=3.75094; df=10/763; P<.01
* P<.05, ** P<.01

Table 32. Hotelling's T^2 of Normative Beliefs (NBj) of Important Referents by Powerful Others Nuclear Locus of Control (PNLOC)

NBj	PNLOC	n	Mean	SD	F
Most members of my family	H-PNLOC	362	-.006	1.453	10.63**
	L-PNLOC	412	.323	1.347	
Enterprise groups	H-PNLOC	362	1.428	1.154	1.51
	L-PNLOC	412	1.323	1.224	
Environmental protection experts	H-PNLOC	362	-1.365	1.372	11.62**
	L-PNLOC	412	-1.012	1.489	
Most government officials	H-PNLOC	362	1.536	1.034	1.61
	L-PNLOC	412	1.439	1.073	
Members of the power company	H-PNLOC	362	1.627	1.097	1.31
	L-PNLOC	412	1.534	1.151	
Local residents	H-PNLOC	362	-2.055	1.284	3.05
	L-PNLOC	412	-1.896	1.254	
Anti-nuclear power groups	H-PNLOC	362	-1.890	1.398	.11
	L-PNLOC	412	-1.857	1.389	
General population	H-PNLOC	362	.337	1.371	.57
	L-PNLOC	412	.410	1.331	

H-PNLOC: high score of powerful others nuclear locus of control
L-INLOC: low score of powerful others nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.97285; Exact F=2.66834; df=8/765; P<.01
** P<.01

In regard to motivations, there were no significant differences between the two groups (see Table 33). However, both groups of students were willing to do what most family members and environmental protection experts want them to do.

Powerful Others Nuclear Locus of Control and Its Impact on Attitude, Subjective Norm, and Behavioral Intention

It is seen in Table 34 that the group of students scoring low on powerful others nuclear locus of control (PNLOC) more than the group scoring high on PNLOC expressed significantly greater favorable attitude and behavioral intention, and perceived that most important referents wanted them to vote in favor of the proposal of new nuclear power plants.

External Factors on Attitude, Subjective Norm, and Behavioral Intention

To examine if external factors had a direct impact on behavioral intention, attitude and subjective norm variables statistic analysis of correlation was conducted. Results indicated that the impact of external factors on behavioral intention was influenced by the presence of attitude and subjective norm variables, and the true predictability of the external factors on behavioral intention was only at 1.15% (see Table 35).

Table 33. Hotelling's T^2 of Motivations to Comply with Important Referents (MCj) by Powerful Others Nuclear Locus of Control (PNLOC)

MCj	PNLOC	n	Mean	SD
Most members of my family	H-PNLOC	362	4.961	1.222
	L-PNLOC	412	5.056	1.218
Enterprise groups	H-PNLOC	362	3.080	1.419
	L-PNLOC	412	3.138	1.380
Environmental protection experts	H-PNLOC	362	5.246	1.162
	L-PNLOC	412	5.180	1.239
Most government officials	H-PNLOC	362	3.555	1.380
	L-PNLOC	412	3.706	1.350
Members of the power company	H-PNLOC	362	3.823	1.357
	L-PNLOC	412	3.898	1.372
Local residents	H-PNLOC	362	4.052	1.340
	L-PNLOC	412	3.978	1.362
Anti-nuclear power groups	H-PNLOC	362	3.862	1.423
	L-PNLOC	412	3.633	1.307
General population	H-PNLOC	362	4.511	1.210
	L-PNLOC	412	4.517	1.227

H-PNLOC: high score of powerful others nuclear locus of control
L-INLOC: low score of powerful others nuclear locus of control
Wilks multivariate test of significance:
Wilks Lambda=.98770; Exact F=1.19039; df=8/765; P>.05

Table 34. One-Way ANOVA of Attitude (Ab), Subjective Norm (SN), and Behavioral Intention (BI) by Powerful Others Nuclear Locus of Control (PNLOC)

Variables	PNLOC	n	Mean	SD	F
Attitude	H-PNLOC	362	.0727	1.4868	26.64**
	L-PNLOC	412	.6084	1.3988	
Subjective Norm	H-PNLOC	362	-.2127	1.4925	21.02**
	L-PNLOC	412	.2561	1.3515	
Behavioral Intention	H-PNLOC	362	.1022	1.9015	20.57**
	L-PNLOC	412	.6869	1.6848	

H-PNLOC: high score of powerful others nuclear locus of control
L-PNLOC: low score of powerful others nuclear locus of control
** P<.01

Table 35. Simple and Multiple Correlation Coefficients of Attitude, Subjective Norm, and Behavioral Intention by External Variables

Depnt	Var.	r	R	+R	+R^2	F-change
BI	PA	.2464**	.8741**	.0004	.0091	3.9354*
	Res.	.1032*	.8744**	.0007	.0012	3.3542*
	INLOC	.1209**	.8739**	.0002	.0012	3.2541*
	PNLOC	-.1826**	.8731**	-.0006	.0000	.8541

r: correlation coefficient between BI and external variable
R: correlation coefficient of BI by external variable, Ab, and SN
+R: additional correlation due to adding external variable to Ab, SN
R^2: additional R^2 by adding external variable to Ab, SN
F-change: F value change due to external variable
PA: party affiliation

Differences of Beliefs and Evaluations of Outcomes, Attitude, Normative Beliefs, Motivations, and Subjective Norm Among Different Groups of Behavioral Intention

To better understand the differences in beliefs and evaluations of outcomes, attitude, normative beliefs, motivations, and subjective norm among different behavioral intention groups, subjects were divided into "support," "not in favor," and "undecided" groups.

Subjects who scored +3 to +1 on behavioral intention are grouped as the support group. Subjects who scored -1 to -3 are grouped as the not in favor group, and subjects who scored zero are grouped as the undecided group.

Beliefs of Outcomes

The results of beliefs of outcomes among the three groups of behavioral intention are summarized in Table 36. The support group more than the not in favor group showed significantly more favorable beliefs of outcomes. At same time, the undecided group more than the not in favor group expressed significantly more favorable beliefs on "urge the government to develop new tests of nuclear safety systems," "increase public participation in nuclear decisions," "solve the problem of future energy shortages," and "increase the danger from radioactive materials and wastes." Although the support group had significantly more favorable beliefs than the not in favor group on the nine items of beliefs, these groups showed significantly more unfavorable beliefs on "increasing the danger from radioactive materials and

Table 36. One-Way ANOVA of Beliefs of Outcomes (Bi) by Behavioral Intention (BI)

Bi	BI	n	Mean	SD	F	Scheffe's
Urge government to develop new safe systems of tests	(1)SUP	485	.942	1.019	68.43**	(1)>(2)
	(2)NIF	236	-.102	1.336		(2)<(3)
	(3)UND	53	.585	1.008		
Increase public participation in nuclear decisions	(1)SUP	485	.184	1.204	32.53**	(1)>(2)
	(2)NIF	236	-.610	1.318		(2)<(3)
	(3)UND	53	-.094	1.197		
Ensure low-cost electricity	(1)SUP	485	.617	1.363	17.93**	(1)>(2)
	(2)NIF	236	-.034	1.432		
	(3)UND	53	.264	1.273		
Help economic development	(1)SUP	485	1.641	.957	49.99**	(1)>(2)
	(2)NIF	236	.903	.943		(1)>(3)
	(3)UND	53	1.076	1.035		
Solve future energy shortages	(1)SUP	485	.355	1.412	40.70**	(1)>(2)
	(2)NIF	236	-.644	1.353		(2)<(3)
	(3)UND	53	.076	1.426		
Increase danger from radioactive materials, wastes	(1)SUP	485	1.301	1.097	31.44**	(1)<(2)
	(2)NIF	236	1.992	1.099		(2)>(3)
	(3)UND	53	1.567	1.101		
Arouse threat of catastrophe	(1)SUP	485	1.313	1.091	18.38**	(1)<(2)
	(2)NIF	236	1.848	1.150		
	(3)UND	53	1.453	1.153		
Cause destruction of the ecological environment	(1)SUP	485	1.262	1.122	35.79**	(1)<(2)
	(2)NIF	236	2.013	1.124		
	(3)UND	53	1.623	1.113		
Result in more nuclear plants	(1)SUP	485	.584	1.236	10.48**	(1)<(2)
	(2)NIF	236	1.047	1.382		
	(3)UND	53	.774	1.138		
Increase threat of nuclear theft and sabotage	(1)SUP	485	.371	1.238	26.87**	(1)<(2)
	(2)NIF	236	1.093	1.262		
	(3)UND	53	.717	1.246		

SUP: support
NIF: not in favor
UND: undecided
** P<.01

wastes," "arousing the theft of catastrophe," and "causing the destruction of ecological environment."

Evaluations of Outcomes

It is shown in Table 37 that the support group of behavioral intention more than the not in favor group expressed significantly more favorable evaluations on all the items of evaluations. On the other hand, the undecided group of behavioral intention had significantly more favorable evaluations than the not in favor group on "urge the government to develop new tests of nuclear safety systems," "help economic development," "solve the problem of future energy shortages," "increase the danger from radioactive materials and wastes," and "cause the destruction of ecological environment." Although the support group showed significantly more favorable evaluations than the not in favor group, these two groups expressed significantly more unfavorable evaluations on "increase the danger from radioactive materials and wastes," "arouse the threat of catastrophe," and "cause the destruction of the ecological environment."

Normative beliefs of Important Referents

It was presented in Table 38 that the support group more than the not in favor group perceived important social referents except most governmental officials as wanting them to vote in favor of the proposal of new nuclear power plants.

Table 37. One-Way ANOVA of Evaluations of Outcomes (Ei) by Behavioral Intention (BI)

Ei	BI	n	Mean	SD	F	Scheffe's
Urge government to develop new safe systems of tests	(1) SUP	485	.870	1.169	53.08**	(1)>(2)
	(2) NIF	236	-.182	1.489		(2)<(3)
	(3) UND	53	.396	1.392		(1)>(3)
Increase public participation in nuclear decisions	(1) SUP	485	.280	1.356	20.17**	(1)>(2)
	(2) NIF	236	-.423	1.524		
	(3) UND	53	-.038	1.208		
Ensure low-cost electricity	(1) SUP	485	.608	1.375	20.33**	(1)>(2)
	(2) NIF	236	-.093	1.438		
	(3) UND	53	.302	1.280		
Help economic development	(1) SUP	485	1.513	.948	63.29**	(1)>(2)
	(2) NIF	236	.602	1.175		(1)>(3)
	(3) UND	53	1.132	.941		(2)<(3)
Solve future energy shortages	(1) SUP	485	-.167	1.538	21.06**	(1)>(2)
	(2) NIF	236	-.928	1.346		(2)<(3)
	(3) UND	53	-.321	1.516		
Increase danger from radioactive materials, wastes	(1) SUP	485	-1.136	1.195	26.71**	(1)>(2)
	(2) NIF	236	-1.826	1.241		(2)<(3)
	(3) UND	53	-1.132	1.210		
Arouse threat of catastrophe	(1) SUP	485	-1.260	1.105	17.06**	(1)>(2)
	(2) NIF	236	-1.767	1.130		
	(3) UND	53	-1.566	1.010		
Cause destruction of the ecological environment	(1) SUP	485	-1.099	1.207	44.34**	(1)>(2)
	(2) NIF	236	-1.996	1.176		(2)<(3)
	(3) UND	53	-1.302	1.265		
Result in more nuclear plants	(1) SUP	485	-.200	1.347	13.93**	(1)>(2)
	(2) NIF	236	-.771	1.538		
	(3) UND	53	-.604	1.115		
Increase threat of nuclear theft and sabotage	(1) SUP	485	-.332	1.297	16.37**	(1)>(2)
	(2) NIF	236	-.911	1.320		
	(3) UND	53	-.679	1.070		

SUP: support
NIF: not in favor
UND: undecided
** P<.01

Table 38. One-Way ANOVA of Normative Beliefs (NBj) by Behavioral Intention (BI)

NBj	BI	n	Mean	SD	F	Scheffe's
Most members of my family	(1)SUP	485	.777	1.029	21.352**	(1)>(2)
	(2)NIF	236	-1.072	1.314		(1)>(3)
	(3)UND	53	.132	1.144		(2)<(3)
Enterprise groups	(1)SUP	485	1.493	1.067	7.294**	(1)>(2)
	(2)NIF	236	1.136	1.414		
	(3)UND	53	1.321	1.052		
Environmental protection experts	(1)SUP	485	-.788	1.396	61.485**	(1)>(2)
	(2)NIF	236	-1.970	1.246		(2)<(3)
	(3)UND	53	-1.208	1.276		
Most government officials	(1)SUP	485	1.538	.919	4.338*	(1)>(3)
	(2)NIF	236	1.462	1.253		
	(3)UND	53	1.094	1.197		
Members of the power company	(1)SUP	485	1.732	.966	12.581**	(1)>(2)
	(2)NIF	236	1.322	1.361		(1)>(3)
	(3)UND	53	1.302	1.102		
Local residents	(1)SUP	485	-1.833	1.295	13.919**	(1)>(2)
	(2)NIF	236	-2.322	1.121		(2)<(3)
	(3)UND	53	-1.660	1.358		
Anti-nuclear power groups	(1)SUP	485	-1.817	1.354	9.942**	(1)>(2)
	(2)NIF	236	-2.127	1.337		(1)<(3)
	(3)UND	53	-1.245	1.720		(2)<(3)
General population	(1)SUP	485	.802	1.090	83.827**	(1)>(2)
	(2)NIF	236	-.449	1.480		(1)>(3)
	(3)UND	53	.151	1.133		(2)<(3)

SUP: support
NIF: not in favor
UND: undecided
* P<.05, ** P<.01

At the same time, the undecided group significantly more than the not in favor group perceived that most family members, environmental protection experts, local residents near nuclear power plants, anti-nuclear power groups, and the general population wanted them to vote "yes."

On the other hand, all three groups perceived enterprise groups, most governmental officials, and members of the power company as wanting them to vote "yes," and environmental protection experts, local residents near nuclear power plants, and anti-nuclear power groups as wanting them to vote "no."

Motivations to Comply with Important Referents

The results in Table 39 show that the support group more than the not in favor group was willing to do what most members of their families, enterprise groups, most governmental officials, and members of the power company think they should do.

On the contrary, the not in favor group more than the support group was willing to do what local residents near nuclear power plants and anti-nuclear power groups think they should do. However, there was no significant difference on "environmental protection experts." All three groups were willing to do what environmental protection experts think they should do.

Table 39. One-Way ANOVA of Motivations to Comply with Important Referents (MCj) by Behavioral Intention (BI)

MCj	BI	n	Mean	SD	F	Scheffe's
Most members of my family	(1)SUP	485	5.128	1.139	7.174**	(1)>(2)
	(2)NIF	236	4.869	1.357		(1)>(3)
	(3)UND	53	4.585	1.151		
Enterprise groups	(1)SUP	485	3.361	1.353	23.829**	(1)>(2)
	(2)NIF	236	2.619	1.380		
	(3)UND	53	3.019	1.308		
Environmental protection experts	(1)SUP	485	5.198	1.142	1.705	
	(2)NIF	236	5.292	1.256		
	(3)UND	53	4.962	1.467		
Most government officials	(1)SUP	485	3.909	1.253	29.641*	(1)>(2)
	(2)NIF	236	3.110	1.437		
	(3)UND	53	3.472	1.339		
Members of the power company	(1)SUP	485	4.128	1.260	29.113**	(1)>(2)
	(2)NIF	236	3.331	1.438		(1)>(3)
	(3)UND	53	3.811	1.272		
Local residents	(1)SUP	485	3.893	1.336	6.182**	(1)<(2)
	(2)NIF	236	4.267	1.393		(2)<(3)
	(3)UND	53	3.981	1.152		
Anti-nuclear power groups	(1)SUP	485	3.439	1.248	41.912**	(1)<(2)
	(2)NIF	236	4.381	1.429		(2)>(3)
	(3)UND	53	3.642	1.145		
General population	(1)SUP	485	4.565	1.195	1.185	
	(2)NIF	236	4.441	1.289		
	(3)UND	53	4.377	1.096		

SUP: support
NIF: not in favor
UND: undecided
* P<.05, ** P<.01

Attitude, and Subjective Norm

The results shown in Table 40 indicate that the support group and undecided group of behavioral intention more than the not in favor group showed significantly more favorable attitude and were willing to do what most important referents think they should do for the proposal of new nuclear power plants. In addition, the support group more than the undecided group expressed significantly more favorable attitude and were willing to do what most important referents think they should do.

Table 40. One-Way ANOVA of Attitude (Ab), Subjective Norm (SN) by Behavioral Intention (BI)

Variables	BI	n	Mean	SD	F	Scheffe's
Ab	(1)SUP	485	1.173	.892	528.97**	(1)>(2)
	(2)NIF	236	-1.283	1.073		(1)>(3)
	(3)UND	53	.201	.914		(2)<(3)
SN	(1)SUP	485	.800	.923	414.49**	(1)>(2)
	(2)NIF	236	-1.479	1.144		(1)>(3)
	(3)UND	53	-.198	.977		(2)<(3)

SUP: support
NIF: not in favor
UND: undecided
** p<.01

Discussion

This study assessed the various variables affecting the reasoned action related to voting regarding new nuclear power plants and the relationships among these variables.

In addition, the effects of external factors including demographic variables and nuclear locus of control on reasoned action concerning nuclear power plants were investigated.

Discussion of the results of the study is presented in the following sections: 1) assessment of behavioral intention, attitude, subjective norm, and relationships among these three variables; 2) assessment of beliefs and evaluations of outcomes, and relationships between attitude and these two variables; 3) assessment of subjective norm, normative beliefs of important referents, motivations to comply with important referents, and relationships among these three variables; 4) external factors affecting behavioral intention; 5) relationships of behavioral intention with subcomponents of reasoned action; 6) differences of beliefs and evaluations of outcomes, attitude, normative beliefs, motivations, subjective norm among different groups of behavioral intention; and 7) application of Fishbein's model in the study of reactions to the proposal of new nuclear power plants.

Assessment of Behavioral intention, Attitude, and Subjective Norm

The percentage of subjects who intended to vote "yes" was 62.6% as opposed to 30.6% who intended to vote against new nuclear power plants. The behavioral intention in this study was compared with results of a study conducted by Bowman and Fishbein (1978) using the same type of

instrument. In Bowman and Fishbein's report (N = 89), it was shown that 43% of respondents intended to vote against placing restrictions on nuclear power plant construction, and 44% intended to vote in favor of placing restrictions. In the same report, the percentages of intention to vote against placing restrictions were 55% for subjects in the Portland, Oregon, area and 58% for those in Oregon state, and the percentages of intention to vote in favor of placing restrictions were 45% for subjects in the Portland area and 42% for those in Oregon state. So, the percentage of intention to vote "yes" to build new nuclear power plants was higher in this study than in Bowman and Fishbein's study.

The students' mean scores of three items of attitude were .274, .413, and .386. In comparison with the study of Bowman and Fishbein (1978), the attitude of subjects in this study was slightly more favorable to vote "yes" for building new nuclear power plants. The mean scores and percentages of the subjective norm (important referents) were .035 and .039 and 48.2% and 45.2%, respectively, for supporting new nuclear power plants. Again, the percentages of important referents who supported voting "yes" in this study were higher than those in Bowman and Fishbein's study.

The fact that the percentages of favorable behavioral intention, attitude, and important referents toward building new nuclear power plants were higher in this study than

those in Bowman and Fishbein's study may be attributed to subjects in Taiwan have been seriously affected by electricity shortages for many summers; hence they were eager to solve this problem. In addition, government officials in Taiwan tended to provide effective communication to residents about the advantages of nuclear energy.

Relationships Among Behavioral Intention, Attitude, and Subjective Norm

The correlation coefficients of behavioral intention with attitude and subjective norm in this study were .8519 and .7760, respectively. In the study of the Oregon Nuclear Safeguards Initiative (Bowman & Fishbein, 1978), the correlation coefficients were .91 and .72. In this study the values of the relative importance of attitude and subjective norm toward behavioral intention were .62 and .30, respectively, and in Bowman and Fishbein's study, the values were .80 for attitude and .17 for subjective norm. The correlation coefficient of behavioral intention with both attitude and subjective norm together in this study was .87, while in Bowman and Fishbein's study it was .92.

As a whole, the relationships among behavioral intention and attitude and subjective norm in both studies were very strong, and the predictive capacity of attitude was greater than that of subjective norm toward intention. These results were consistent with the theory of Fishbein's model which is based on the assumption that human behaviors

are usually quite rational and people tend to make systematic use of the information available to them for behavioral decisions (Ajzen & Fishbein, 1980).

Assessment of Beliefs and Evaluations of Outcomes

Eight questions were used to assess beliefs of consequences in this study, the same as in Bowman and Fishbein's study (1978). Slightly more subjects in this study believed that voting "yes" for building new nuclear power plants would ensure low-cost electricity, help economic development, and solve the problem of future energy shortages. Subjects in this study also believed that voting "yes" would urge the government to develop new tests of nuclear safety systems. On the other hand, subjects believed that voting "yes" would increase the danger of radioactive materials and wastes, result in more nuclear power plants, and increase the threat of nuclear theft and sabotage, and they also believed that voting "yes" would arouse threats of catastrophe and destruction of the ecological environment. These results were consistent with the findings from Bowman and Fishbein's study.

Regarding the evaluations of outcomes, subjects in this study more than those in Bowman and Fishbein's study (1978) believed that voting "yes" could increase chances that the government would develop new tests of nuclear safety systems, increase public participation in nuclear decisions, ensure low-cost electricity, and help economic development.

However, subjects in both studies evaluated that voting "yes" could not solve the problem of future energy shortages, could increase the danger of radioactive materials and wastes, could result in more nuclear power plants, and could increase threats of nuclear theft and sabotage. The subjects in this study also evaluated that voting "yes" could arouse threats of catastrophe and destruction of the ecological environment. Similar results for beliefs and evaluations toward advantages and disadvantages of nuclear energy also were found in the study of Hughey (1981).

As a whole, subjects in this study, when compared with those in the study of Bowman and Fishbein, were more likely to favorably evaluate the advantages of nuclear energy for economic development, low-cost electricity, the high quality of life, and less pollution. At the same time, subjects in this study also were more concerned about the disadvantages of nuclear energy in polluting the environment and causing an adverse impact on human health.

These differences in beliefs and evaluations may be explained by the fact that most people in Taiwan have been disturbed by electricity shortages for many summers, and therefore hoped to solve this problem as quickly as possible, and the government usually has emphasized the advantages of nuclear energy for the quality of life and for economic development. On the other hand, researchers (Hatch

& Susser, 1990; Johnson, 1980; Milhaud, 1991; IAEA, 1986) reported that people living close to nuclear power plants are significantly more influenced by nuclear power plant accidents. Taiwan is a small island, and most people live close to nuclear power plants. Therefore, they are more likely to be influenced by negative reports about nuclear power plants. Results of this study were in agreement with these research studies.

Furthermore, 10 to 20% of subjects showed no opinions about some issues related to nuclear power plants. This may indicate that these subjects lacked enough knowledge of nuclear energy to make definite decisions. Environmental educators have advocated that environmental knowledge affects behavior through attitude and behavioral intention, and environmental knowledge is essential for citizens' responsible environmental behavior (Stapp, 1985; Stapp & Polunin, 1991; Roth, 1972). Sothern (1972) also indicated that "if the child acquires particular broad environmental understandings (knowledge), he will develop social conscience (attitude) that will affect his behavior (actions) toward the environment" (p. 16). It appears that there is a need for nuclear energy education in the curriculum for students at teacher-training universities.

Relationships Among Attitude, Beliefs, and Evaluations of Outcomes

The correlation coefficients of attitude with beliefs of outcomes, evaluations, and the product of beliefs of

outcomes weighted by evaluations of outcomes in this study were .5929, .5669, and .4037, respectively, and .7534 for beliefs of outcomes and evaluations of outcomes. These results were consistent with the results of Bowman and Fishbein's study (1978) and other studies using Fishbein's model to examine health behaviors (Sejwacz, 1977; Sperber, 1974; Fishbein, 1973; Pomazal, 1976; Yang, 1991). All of these studies showed positive correlations between these variables.

Assessment of Normative Beliefs of Important Referents

According to the theory of reasoned action (Ajzen & Fishbein, 1980), behavioral intention could be influenced by normative beliefs of important referents. For this study, most family members, most governmental officials, most members of the power company, enterprise groups, and the general population were found to be important referents that affected students voting in favor of building new nuclear power plants. On the other hand, environmental protection experts, local residents near nuclear power plants, and anti-nuclear power groups thought students should vote "no." They indicated that most family members, most governmental officials, and members of the power company are important referents that influence their voting in favor of new nuclear power plants, and environmental protection experts are important referents to influence their voting "no." The

results were very similar to the results from Bowman and Fishbein's study.

Students' normative beliefs of important referents tend to be affected by media and some of the studies published in Taiwan. Shih (1991) reported that the capacity of the current electric system in the Taiwan area may not be enough by the year 2000, and nuclear power plants are a better option for economic development, low-cost electricity, and the natural environment. W. C. Liou (1991) also reported that besides economic benefits (helping the prosperous growth of commercial and industrial development, and increasing the high life quality) there are additional advantages of nuclear energy which include the stability of energy sources, the inhibition of a greenhouse effect caused by air pollution, an environment with fewer pollutants, and an inexhaustive source.

On the other hand, news of nuclear power plant accidents such as Three Mile Island and Chernobyl tend to influence students' normative beliefs about the uncertainty and the safety perspective of nuclear power plants. As a result, they perceived that environmental protection experts, residents living near nuclear power plants, and people who are opposing nuclear power plants would be important referents affecting their voting behavior.

Assessment of Motivations to Comply with Important Referents

There were four questions used to assess motivations to comply with important referents. Results indicated that subjects in this study more than those in Bowman and Fishbein's study were willing to do what most members of their families and environmental protection experts wanted them to do. However, students were less likely to do what enterprise groups, most governmental officials, members of the power company, and anti-nuclear power groups wanted them to do.

Traditionally, family values are rated very high among students in Taiwan, and this is reflected in the results of this study. Students tended to be influenced more by family members than other referents. In addition, students in Taiwan also are more likely to respect authority figures. Therefore, they tended to be influenced by family members and environmental protection experts.

Relationships Among Subjective Norm, Normative Beliefs, and Motivations to Comply with Important Referents

The correlation coefficients of subjective norms with normative beliefs, motivations to comply with important referents, and the product of normative beliefs weighted by the motivations were .5963, .1319, and .6354, respectively. These correlationships were significant enough to further support the interrelationships among these variables concerning subjective norm, normative beliefs, and motivations to comply with important referents. These

results were in agreement with the results from Bowman and Fishbein's study which indicated that normative beliefs and motivations to comply were the immediate determinants of subjective norm.

External Factors Affecting Behavioral Intention

External factors examined in this study were age, school, gender, socioeconomic status (SES), political party affiliation, county of residence near/not near nuclear power plants, residence with/without industrial pollution, and nuclear locus of control (NLOC) including internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC). Results of correlational analysis revealed four external variables (party affiliation, residence with/without industrial pollution, INLOC, and PNLOC) demonstrated significant correlation with behavioral intention. Due to the significant relationships between these four external variables and behavioral intention, the relationships of each of these four external variables with the subcomponents of the Fishbein model were further analyzed.

Political Party Affiliation

Ajzen and Fishbein (1980) have indicated that political party affiliation is an important variable to predict whether a person would vote for or against the nuclear

safeguards referendum. Results of this study tend to support their theory.

Generally, supporters of the political ruling party, Kuomintang (KMT), were more likely than those of the Democratic Progressive Party (DPP) to vote in favor of building new nuclear power plants. It appears that supporters of the ruling party also are more likely to support the nuclear power policy favored by the ruling party. It is evident that the current government is in favor of nuclear energy. Therefore, supporters of this government also support nuclear energy. The political party affiliation affects not only the behavioral beliefs and evaluations of outcomes but also motivations to comply with important referents, attitude, and subjective norm, which eventually affects the behavioral intention to vote for supporting nuclear power plants.

Residence With/Without Industrial Pollution

Results of this study indicated that residence with or without industrial pollution is an important external factor that will influence the behavioral intention for voting in favor of building nuclear power plants. Shih (1991) and Hendrie (1983) had indicated that subjects whose residences have not been affected by pollution tend to support the idea that nuclear power will help to increase economic development and improve the quality of life. Nuclear energy has been perceived as a way to increase industrial and

commercial development, reduce environmental pollution, and promote a higher quality of life. Therefore, subjects with no previous negative experience with pollution tend to support nuclear power plants.

However, subjects whose residences have been affected by pollution tend to be against nuclear power plants. They perceived that the government in Taiwan does not have the capability to build nuclear power plants without causing any adverse effects on the environment because the government caused their residences to be polluted, and they were influenced by scholars' reports which suggested nuclear power plants would cause a harmful environment for humans (Hatch & Susser, 1990; Johnson, 1980; Beral et al., 1985; Milhaud, 1991).

Internal Nuclear Locus of Control and Powerful Others Nuclear Locus of Control

Subjects with high scores on internal nuclear locus of control (INLOC) and low scores on powerful others nuclear locus of control (PNLOC) demonstrated more favorable beliefs of outcomes, evaluations of outcomes motivations (except for PNLOC), attitude, subjective norm, and behavioral intention than subjects scoring low on INLOC and scoring high on PNLOC for voting in favor of building new nuclear power plants.

According to the theory of Erdahl and Rounds (1986), subjects who scored high on INLOC and low on PNLOC feel more confident in the future and have better capability to handle the environment. As a result, these subjects tend to

believe that nuclear power is safe and that it is more helpful for economic development and a better quality of life.

On the other hand, subjects who scored low on INLOC and high on PNLOC may lack confidence in the future and show no capability to influence the environment. Therefore, these subjects are more likely to be affected by reports of nuclear accidents. Newcomb (1989) followed a group of students in the United States in 1984, 1986, and 1987, related to their concerns about nuclear energy. He found students had increased concerns about nuclear accidents each year, particularly in 1986 after the Chernobyl accident. It appears that students with low scores on INLOC and high scores on PNLOC tend to be more easily affected by reports of nuclear incidents. So, they are unlikely to be supportive of nuclear power plants.

Impact of External Factors on Behavioral Intention

While four external variables were significantly correlated with behavioral intention to vote in favor of new nuclear power plants, the explanation power (R^2) of the behavioral intention by external variables (political party affiliation, residence with/without industrial pollution, INLOC) was only 1.15%. This result further supports Fishbein's theory of reasoned action. The researchers indicated that external variables influence behavioral intention indirectly through their impact on attitude and

subjective norm. Therefore, it is important to examine external factors such as sociodemographic data, residence, political party affiliation, and locus of control when predicting a behavioral intention by using the reasoned action model.

Differences of Beliefs and Evaluations of Outcomes, Normative Beliefs, Motivations, Attitude, and Subjective Norm Among Different Groups of Behavioral Intention

Students supporting new nuclear power plants showed higher scores on beliefs and evaluations of outcomes, normative beliefs, motivations, attitude, and subjective norm than students who oppose new nuclear power plants. The percentage of students who supported nuclear power plants was higher than the results reported by Ajzen and Fishbein (1980). This may indicate that a majority of students in Taiwan were significantly influenced by electricity shortages and therefore are eager to solve this problem by supporting new nuclear power plants.

Application of Fishbein's Model in the Study of Reactions to the Proposal of New Nuclear Power Plants

The theory of Fishbein's model is based on the assumption that human behavior is usually quite rational and it is the result of decisions made by systematic use of the information available. The model also indicates that a person's behavior is assumed to be a function of his behavioral intention, which in turn is a function of a) attitudes toward the behavior; and b) subjective (social) norm regarding the behavior. The attitudinal component of

the model (Ab) has consistently been shown to be highly related to an individual's beliefs that the behavior in question will lead to certain consequences, weighted by his evaluations of those consequences; the subjective norm component of the model (SN) has been shown to be related to the individual's normative beliefs about what significant others think he should do, weighted by his motivations to comply with significant others.

Overall, the results of this study were able to support Fishbein's theory (see Figure 3). The behavioral intention of voting toward the proposal of new nuclear power plants was successfully predicted by beliefs and evaluations of outcomes, normative beliefs, motivations, attitude, and subjective norm. Data indicated that the predicting power of behavioral intention from attitude and subjective norm was 72.57% and 60.22%, respectively. Additionally, behavioral beliefs of outcomes, evaluations of outcomes, and the product beliefs of outcomes weighted by evaluations of outcomes were able to project attitude at 35.15%, 32.14%, and 16.30% levels, respectively, and normative beliefs of special referents, motivations to comply with specific referents, and the product of normative beliefs weighted by motivation were able to project subjective norm at 35.56%, 1.74%, and 40.37% levels, respectively.

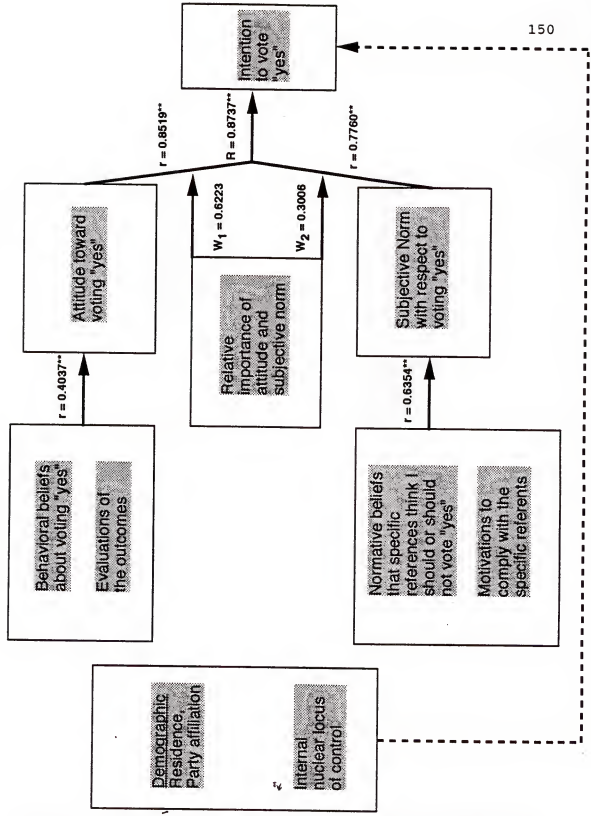
Intention to vote "yes"
r = 0.8519**
R = 0.8737**
r = 0.7760**
Attitude toward voting "yes"
W1 = 0.6223
W2 = 0.3006
Subjective Norm with respect to voting "yes"
r = 0.4037**
Relative importance of attitude and subjective norm
r = 0.6354**
Behavioral beliefs about voting "yes"
Evaluations of the outcomes
Normative beliefs that specific references think I should or should not vote "yes"
Motivations to comply with the specific referents
Demographic Residence, Party affiliation
Internal nuclear locus of control

Figure 3. Model Illustrating Various Factors Affecting Reasoned Action (Behavioral Intention to Vote "Yes" for New Nuclear Power Plants)

CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to examine the beliefs and evaluations of behavioral outcomes, attitude, behavioral intention, subjective norm, normative beliefs, motivations to comply with important referents, and behavioral intention toward the proposal of new nuclear power plants. This study also attempted to utilize Fishbein's model of reasoned action to predict behavioral intention of voting regarding building new nuclear power plants.

The population of the study consisted of undergraduate students enrolled in the three teacher-training universities in Taiwan, Republic of China, during the fall semester of 1992. The sample was selected from the first-year students. The total number of students who participated in the study was 774 (male 40.7%; female 59.3%).

The survey instrument contained 51 single-response items along with items which asked subjects about political party affiliation and demographic characteristics. Of the single-response items, 10 were used to measure beliefs about the consequences of voting "yes" for the proposal of new nuclear power plants, and 10 were used to measure the corresponding evaluations of the consequences. With regard

to subjective norm, eight items were used to measure normative beliefs and eight items were utilized to measure motivations to comply with social referents. This study also adopted and modified the Nuclear Locus of Control Scales (NLOC) which contained three parts, internal nuclear locus of control (INLOC), powerful others nuclear locus of control (PNLOC), and chance nuclear locus of control (CNLOC), each of which included six items to measure beliefs about accidents of nuclear power plants and nuclear policy.

The survey was administered to all students in attendance on the day of survey. In order to standardize the data collection procedure, all surveys were administered by the researcher with the assistance of the professor who was responsible for the class being sampled.

The data collected from the subjects then were analyzed by using the SPSS/PC+ package. Descriptive data were analyzed and presented as means and standard deviations, and frequencies and percentages. Data related to relationships among variables were analyzed by procedures of one-way ANOVA, one-way MANOVA, correlations, and simultaneous multiple regressions.

The main findings of the study are presented here. First, about 55% of the students expressed favorable attitude and behavioral intention of voting in favor of building new nuclear power plants, and a majority of

students (48%) perceived most of the important referents thought they should vote "yes." However, over 20% of the students did not know whether most important referents wanted them to vote "yes" or "no."

Second, there were significantly positive correlations between behavioral intention and attitude, between behavioral intention and subjective norm, and between attitude and subjective norm. In other words, the more favorable the attitude, the more likely the behavioral intention for voting in favor of building new nuclear power plants; the more students perceived that most important referents supported they should vote "yes," the more favorable behavioral intention they had for voting "yes," and the more students perceived that most important referents thought they should vote "yes," the more favorable attitude they had. Attitude was a better variable than subjective norm for predicting the behavioral intention for the proposal of new nuclear power plants.

Third, most of the students showed favorable beliefs and evaluations about urging the government to develop new tests of nuclear safety systems, ensuring low-cost electricity, helping economic development, and solving the problems of future energy shortages. At the same time, most students expressed the unfavorable beliefs that nuclear power plants would increase the danger from radioactive materials and wastes, arouse the threat of catastrophe,

cause the destruction of the ecological environment, result in more new nuclear power plants, and increase the threat of nuclear theft and sabotage. There also were many negative beliefs, and 10 to 20% of students were unable to express their beliefs and evaluations of the behavioral outcomes.

Fourth, there were significant positive correlations between attitude and beliefs of outcomes, between attitude and evaluations of outcomes, and between attitude and the product of the beliefs about outcomes weighted by evaluations of outcomes.

Fifth, a majority of students (over 50%) perceived that most members of their families, enterprise groups, most government officials, members of the power company, and the general population thought they should vote in favor of building new nuclear power plants, and perceived that environmental protection experts, local residents near nuclear power plants, and anti-nuclear power groups thought they should not vote "yes." A majority of students (over 64%) were willing to do what most members of their families, environmental protection experts, and the general population wanted them to do, but were not willing to do what enterprise groups wanted. There were significant positive correlations between subjective norm and normative beliefs, between subjective norm and motivations to comply with important referents, and between subjective norm and the

product of normative beliefs weighted by motivations, all of which were consistent with the theory of reasoned action.

Sixth, political party affiliation, residence with/without industrial pollution, internal nuclear locus of control (INLOC), and powerful others nuclear locus of control (PNLOC) were significantly correlated with behavioral intention.

Seventh, supporters of Kuomintang were more likely than those of the Democratic Progressive Party, other parties, and those with no party affiliation to show favorable beliefs and evaluations of outcomes, attitude, and behavioral intention for voting in support of building new nuclear power plants. They also tended to perceive that most of the important referents thought they should vote "yes" and also were willing to do what most of the important referents wanted them to do.

Eighth, students whose place of residence is without industrial pollution showed more favorable behavioral intention for voting in favor of building new nuclear power plants than did those whose place of residence has pollution.

Ninth, the students who scored high on internal nuclear locus of control (INLOC) were more likely to express favorable beliefs and evaluations of outcomes, attitude, and behavioral intention for voting in favor of building new nuclear power plants than those who scored low on INLOC.

They also were more likely to do what most of the important referents wanted them to do.

Tenth, the students who scored low on powerful others nuclear locus of control (PNLOC) more than the students who scored high on PNLOC expressed favorable beliefs and evaluations, attitude, and behavioral intention for voting in favor of building new nuclear power plants, and perceived that most family members and environmental protection experts thought they should vote "yes." There were no significant differences on motivations to comply with important referents between the students who scored low on the PNLOC and those who scored high on the PNLOC.

Eleventh, external factors including political party affiliation, residence with/without industrial pollution, and INLOC tended to influence behavioral intention indirectly through attitude and subjective norm.

Twelfth, students supporting the building of new nuclear power plants tended to show more favorable beliefs, evaluations, and attitude than students who oppose the nuclear power plants. Students supporting the proposal of new nuclear power plants also perceived most of the important referents thought they should vote "yes" and were willing to do what most important referents wanted them to do.

Thirteenth, the results of this study revealed that Fishbein's model of reasoned action was successful in

predicting behavioral intention of voting regarding the proposal of new nuclear power plants.

Conclusions

Based on the findings of this study, the following conclusions are drawn:

First, the instruments (beliefs of outcomes, evaluations of outcomes, attitude, normative beliefs, motivations to comply with important referents, and subjective norm) used in the present study were found to be useful in the understanding of Chinese students' nuclear power concerns.

Second, Fishbein's model of reasoned action was successful in predicting behavioral intention of voting toward the proposal of new nuclear power plants.

Third, among many external factors, political party affiliation, residential area, and nuclear locus of control were able better to predict behavioral intention of voting toward the proposal of nuclear power plants.

Recommendations

Based on the results of the present study, the researcher offers the following recommendations:

1. The knowledge about nuclear energy of students at teacher-training universities should be investigated in order to understand the relationship between knowledge and beliefs of nuclear energy and to analyze the impact of

knowledge on variables of reasoned action using Fishbein's model.

2. The study should be used to examine the beliefs and attitude of the general population in Taiwan about nuclear energy in order to provide information for nuclear experts, environmental educators, and the government for the development of appropriate teaching materials and methods of teaching people through mass media, and develop appropriate nuclear energy policies.

3. Similar studies using Fishbein's model of reasoned action could be conducted to study other environmental health-related behavior such as noise pollution control, air pollution control, water pollution control, and waste recycling problems in Taiwan.

In addition, the following recommendations are made concerning the environmental education programs of nuclear energy in all levels of schools.

1. Information obtained from the study should be considered for the development of environmental education programs.

2. Schools should provide opportunities for students to participate in activities related to nuclear energy such as visiting nuclear power plants.

3. Environmental education concerning nuclear energy should be carried out by schools in cooperation with families, communities, and members of the power company

because the results of this study showed that most family members, members of the power company, and important referents in communities can influence behavior.

APPENDIX A

OPEN-ENDED ELICITATION QUESTIONNAIRE

1. School: _____

2. Sex: Male _____ Female _____

3. What are the advantages of your voting "yes" for building new nuclear power plants?

4. What are the disadvantages of your voting "yes" for building new nuclear power plants?

5. Are there any groups or people who would approve of your voting "yes" for building new nuclear power plants?

6. Are there any groups or people who would disapprove of your voting "yes" for building new nuclear power plants?

APPENDIX B

CLOSED-FORMAT QUESTIONNAIRE
(ENGLISH EDITION)

Letter to the Students

December 1992

Dear Student:

Please read the instructions on the next page before answering this questionnaire on voting for proposed new nuclear power plants. It should not take you more than 30 minutes to finish it.

All of your answers will be kept secret and no attempt will be made to identify you.

Your filling out this questionnaire is very important to me because it is the subject of my doctoral dissertation and without your help I will not be able to graduate.

Thanks for your assistance and cooperation.

Gwo-Liang Yeh
Doctoral Student

Instructions

In the questionnaire you are about to fill out, questions are asked which make use of rating scales with seven places. You are to make a check mark in the place that best describes your opinion. For example, if you were asked to rate the statement "Exercise is good for health" on such a scale, the seven places should be interpreted as follows:

Exercise is good for health

Likely __:__:__:__:__:__:__ Unlikely

If you think "Exercise is good for health" is extremely likely, then you would place your mark as follows:

Exercise is good for health

Likely X__:__:__:__:__:__:__ Unlikely

If you think "Exercise is good for health" is quite likely, then you would place your mark as follows:

Exercise is good for health

Likely __:X__:__:__:__:__:__ Unlikely

If you think "Exercise is good for health" is slightly likely, then you would place your mark as follows:

Exercise is good for health

Likely __:__:X__:__:__:__:__ Unlikely

If you think "Exercise is good for health" is neither likely nor unlikely, then you would place your mark as follows:

Exercise is good for health

Likely __:__:__:X__:__:__:__ Unlikely

You also will be using a rating scale with Good-Bad as endpoints. This scale is to be interpreted in the same way. For example, if you were asked to rate the statement "Exercise for health" on such a scale, it would appear as follows:

Exercise for health is:

Good __:__:__:__:__:__:__ Bad

If you think exercise for health is extremely good, you would make your marks as follows:

Exercise for health is:

x

Good __:__:__:__:__:__:__ Bad

PLEASE be sure you answer all items--please do not omit any. Never put more than one check mark on a single scale.

QUESTIONNAIRE FOR THE STUDY OF PRESERVICE TEACHERS' REACTIONS TO PROPOSED NUCLEAR POWER PLANTS IN TAIWAN: AN APPLICATION OF THE FISHBEIN'S MODEL

PART I. SOCIODEMOGRAPHIC VARIABLES

Please answer the following questions by filling the blanks after the items or circling the number before the proper answer.

1. My birth date: ___, ___, 19___; or my age: ___.

2. My school: _____.

3. My sex: 1)M __ 2)F __.

4. My father:

   1) Illiterate
   2) Elementary School
   3) High School
   4) College/University
   5) Master's/Doctoral Degree

5. My mother:

   1) Illiterate
   2) Elementary School
   3) High School
   4) College/University
   5) Master's/Doctoral Degree

6. My father's occupation _____

7. My mother's occupation _____

8. My political attitude seems closer to:

   1) Current ruling party--Kuomintang
   2) The main party against the ruling party--Democratic Progressive Party
   3) Others (Please specify) _____.

9. Before entering a university, the place I lived most of the time was _____.

10. Before entering a university, the place I lived most of time was located in.

   1) An area with industrial pollution
   2) An area without industrial pollution
   3) Do not know whether the area was with or without industrial pollution

PART II. BEHAVIORAL BELIEFS

1. My voting "yes" on the proposal of new nuclear power plants would urge the government to develop new tests of nuclear safety systems.

Likely ____:____:____:____:____:____:____ Unlikely

2. My voting "yes" on the proposal of new nuclear power plants would increase public participation in nuclear decisions.

Likely ____:____:____:____:____:____:____ Unlikely

3. My voting "yes" on the proposal of new nuclear power plants would ensure low-cost electricity.

Likely ____:____:____:____:____:____:____ Unlikely

4. My voting "yes" on the proposal of new nuclear power plants would help economic development.

Likely ____:____:____:____:____:____:____ Unlikely

5. My voting "yes" on the proposal of new nuclear power plants would solve the problem of future energy shortages.

Likely ____:____:____:____:____:____:____ Unlikely

6. My voting "yes" on the proposal of new nuclear power plants would increase the danger from radioactive materials and wastes.

Likely ____:____:____:____:____:____:____ Unlikely

7. My voting "yes" on the proposal of new nuclear power plants would arouse the threat of catastrophe.

Likely ____:____:____:____:____:____:____ Unlikely

8. My voting "yes" on the proposal of new nuclear power plants would cause the destruction of ecological environment.

Likely ____:____:____:____:____:____:____ Unlikely

9. My voting "yes" on the proposal of new nuclear power plants would result in more new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

10. My voting "yes" on the proposal of new nuclear power plants would increase the threat of nuclear theft and sabotage.

Likely ____:____:____:____:____:____:____ Unlikely

PART III. OUTCOME EVALUATIONS

1. Urging the government to develop new tests of nuclear safety systems.

Good ____:____:____:____:____:____:____ Bad

2. Increasing public participation in nuclear decisions.

Good ____:____:____:____:____:____:____ Bad

3. Ensuring low-cost electricity.

Good ____:____:____:____:____:____:____ Bad

4. Helping economic development.

Good ____:____:____:____:____:____:____ Bad

5. Solving the problem of future energy shortages.

Good ____:____:____:____:____:____:____ Bad

6. Increasing the danger from radioactive materials and wastes.

Good ____:____:____:____:____:____:____ Bad

7. Arousing the threat of catastrophe.

Good ____:____:____:____:____:____:____ Bad

8. Causing the destruction of ecological environment.

Good ____:____:____:____:____:____:____ Bad

9. Resulting in more new nuclear power plants.

Good ____:____:____:____:____:____:____ Bad

10. Increasing the threat of nuclear theft and sabotage.

Good ____:____:____:____:____:____:____ Bad

PART IV. ATTITUDE TOWARD THE BEHAVIOR

1. My voting "yes" on the proposal of new nuclear power plants is/would be

Good ____:____:____:____:____:____:____ Bad

2. My voting "yes" on the proposal of new nuclear power plants is/would be

Wise ____:____:____:____:____:____:____ Foolish

3. My voting "yes" on the proposal of new nuclear power plants is/would be

Beneficial ____:____:____:____:____:____:____ Harmful

Part V. NORMATIVE BELIEFS

1. Most members of my family think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

2. Enterprise groups think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

3. Environmental protection experts think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

4. Most governmental officials think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

5. Members of the power company think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

6. Local residents near nuclear power plants think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

7. Anti-nuclear power groups think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

8. The general population think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

PART VI. MOTIVATIONS

1. Generally speaking, I want to do what most members of my family think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

2. Generally speaking, I want to do what enterprise groups think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

3. Generally speaking, I want to do what environmental protection experts think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

4. Generally speaking, I want to do what most governmental officials think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

5. Generally speaking, I want to do what members of the power company think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

6. Generally speaking, I want to do what local residents near nuclear power plants think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

7. Generally speaking, I want to do what anti-nuclear power groups think I should do.

Likely ____:____:____:____:____:____:____ Unlikely

8. Generally speaking, I want to do what the general population think I should do

Likely ____:____:____:____:____:____:____ Unlikely

PART VII. SUBJECTIVE NORM

Most people who are important to me think I should vote "yes" for building new nuclear power plants.

Likely ____:____:____:____:____:____:____ Unlikely

Support ____:____:____:____:____:____:____ Oppose

PART VIII. BEHAVIORAL INTENTION

I intend to vote "yes" for building new nuclear plants.

Likely ____:____:____:____:____:____:____ Unlikely

PART IX. NUCLEAR LOCUS OF CONTROL SCALES

Form:

Agree _____:_____:_____:_____:_____:_____ Disagree
strongly mostly disagree agree mostly strongly

Internal Nuclear Locus of Control (INLOC)

1. By active participation in the appropriate organizations, I can do a lot to reduce the chances of nuclear power plant accidents.

2. Through political actions, I could influence the possibility of a nuclear power plant accident.

3. If I put my mind to it, I could have an influence on the government about nuclear power policies.

4. Whether or not there is a nuclear power plant accident depends somewhat on my own actions.

5. By efforts on my part, I can have an effect on the number and types of nuclear power plants.

6. I am somewhat responsible for the threat of nuclear power plant accidents.

Powerful Others Nuclear Locus of Control (PNLOC)

1. This country is run by a few people in power and only they can influence governmental policies about nuclear power plants.

2. Powerful people in our society will influence the increase or decrease in the number of nuclear power plants.

3. Whether or not there is a nuclear power plant accident is completely determined by other powerful people.

4. Other powerful people determine governmental policy decisions about nuclear power plants.

5. I feel that only a few powerful people have any important influence over whether or not there is a nuclear power plant accident.

6. Other people influence the increase or decrease in the number of nuclear power plants.

Chance Nuclear Locus of Control (CNLOC)

1. It's chiefly a matter of fate whether or not there will be a nuclear power plant accident.

2. The occurrence of a nuclear power plant accident in my life would simply be due to bad luck.

3. Whether or not the number of nuclear power plants is increased or decreased is a matter of fate.

4. If I live the rest of my life and there isn't a nuclear power plant accident, it is because I am lucky.

5. It seems that the likelihood of a nuclear power plant accident is greatly influenced by accidental happenings.

6. Chance will decide if there is a nuclear power plant accident.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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